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WOUND BALLISTICS

REPORT

BOUGAINVILLE

CAMPAIGN

1944

Oughterson

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A STUDY OF WOUND BALLISTICS

Report on Casualties at Bougainville
from 15 February to 22 April 1944

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1. INTRODUCTION

a. Organization of Team.

In accordance with instructions from the Surgeon General, 21 January 1944, a team was organized for the purpose of conducting a study on wound ballistics. This team included the following personnel:

(1) Colonel Ashley W. Oughterson, O-403382, M.C. Surgeon.

(2) Lt.Colonel Harry C. Hull, O-404308, M.C., Surgeon.

(3) Major Francis A. Sutherland, O-403029, M.C., Surgeon.

(4) Major Daniel J. Greiner, O-317179, M.C., Pathologist.

(5) Sgt. Reed K. Fitch, 33145616, Clerk.

(6) T/4 Charles J. Berzenyi, 32201974, Clerk.

(7) T 5 Charles R. Restifo, 12063356, Photographer.

This team was organized to participate in the contemplated New Ireland operation and was ordered to Guadalcanal for preparation. The New Ireland operation was cancelled and the team was then ordered on detached service with the XIV Corps on Bougainville and reported there on 22 March 1944.

b. Scope of Study.

In order to obtain information on the relative effects of enemy weapons all casualties occurring in the Army ground forces, both living and dead, were studied. The enemy had attacked our perimeter ~~on Bougainville on 6 March~~. This battle was still in progress and arrangements were immediately made for the post mortem examination of those killed in action. At the same time a plan was inaugerated for the study of all battle casualtigs which occurred after 15 February. On that date the 43rd Evacuation Hospital was opened and all Army casualties from ~~Bougainville~~ were thereafter evacuated through this hospital. Since records were readily available at this hospital, all battle casualties from 15 February 1944 to 22 April 1944 were included.

During this period there were a small number of casualties among Navy personnel killed or wounded, mostly by bombs or artillery fire. These were not included.

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adequate information could not be obtained regarding a small number of air corps casualties whose units were based on or had been removed to other islands. For this reason these casualties were excluded. The study was, therefore, limited to the Army Ground Forces.

While it was possible to obtain information on all casualties living and dead for the entire period from 15 February to 22 April, post mortem examinations were limited to the interval extending from 22 March to 22 April. The number of autopsies was further curtailed because the bodies of some of those killed in action during this period were not obtained before decomposition was far advanced. It was also hoped to study the effect of our own weapons on the enemy dead. However, the character of the fighting resulting in multiple wounds by rifle, machine gun, grenade, mortar and artillery fire made it next to impossible to determine what weapon was responsible for death. Furthermore, because of delay in obtaining the Japanese dead, the state of deterioration frequently precluded postmortem examination. Also during this period it often required all the available personnel to perform post mortem examinations on our own troops killed in action.

Since the effect of weapons may be observed on the living as well as the dead, a clinical appraisal especially as regards end results was needed. Furthermore the relative effect of weapons may be greatly influenced by the quality of medical care. For this reason the ballistics team after completing the study on Bougainville followed the patients through the hospitals of the rear echelon.

c. Method of Study.

The battle casualties studied may be divided into two large groups; those killed in action and those wounded in action.

(1) Killed in Action. Those killed in action prior to 23 March were recorded in graves registration. While some of these records were excellent, many were inadequate. The circumstances attending death, such as type of missile, distance from burst, terrain, time, type of protection, etc. were supplemented by personal interviews with the Medical Officers and aid men, or comrades present during the action who had seen the soldier killed or had seen him before he expired. This information is better obtained by personal interview than by questionnaire because the circumstances attending death are so varied. In order to obtain reasonably accurate data, evaluation of the situation by trained and interested personnel is necessary at the time of interview. Subsequent to 23 March 1944 all the dead were brought to the 21st Evacuation Hospital which was located near the cemetery. Here excellent facilities and assistance for post mortem examinations were available. This work was carried on by Major Crelin, who was assisted by a clerk and a photographer. When the number of autopsies exceeded ten or twelve per day, additional assistance was provided by the surgeons. A few additional post mortem

examinations were obtained on those wounded in action, who died later in hospitals of the rear echelon. A card index was kept on all wounded and this was checked for death against the records of the hospitals in the rear echelon. This check was made at a later date and for the majority of patients a period of one to four months had elapsed since they were wounded, hence there is reason to believe that all or nearly all of the dead are recorded in this study.

(2) Wounded in Action. The wounded in action fell into three groups: (a) the more seriously wounded in action who were evacuated from the island; (b) the relatively minor wounds treated and returned to duty from the clearing stations or hospitals usually in one to three weeks; (c) the very minor wounds and abrasions returned to immediate duty from the battalion aid and collecting station. This latter group was not studied. The second group, of minor wounds treated and returned to duty from the clearing stations and hospitals were studied in detail, as were also those evacuated from the Island. Factors relating to ballistics in the wounded in action were obtained by questionnaire and by personal interview. The personal interview was undoubtedly superior but since these troops were still in battle it was sometimes impossible to obtain an interview with an eye witness. When emergency medical tags and hospital records were checked with eye witness accounts, many discrepancies were found as to the weapon, the distance, what the soldier was doing, and the exact circumstances surrounding his injury. Officers, platoon sergeants and privates were questioned regarding effectiveness of enemy weapons and tactics, as well as our own. Questions were also asked regarding the construction of pill-boxes, and the use of camouflage with reference to their effectiveness as a means of protection.

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2. FACTORS PECULIAR TO THIS CAMPAIGN

a. Geography

Bougainville Island is the northern most of the Solomon group lying between latitudes 50°28' S and 5°51' S. It is approximately 130 miles long with an average width of thirty miles. It is a tropical island of volcanic origin with a back bone of rugged mountain ranges. Behind the Empress Augusta Bay sector the Crown Prince range rises to a height of 6500 feet with an active volcano, Mt.Bagana. The Empress Augusta Bay and Torokina Point sector present a low sandy shore line with heavy surf. The south shore of this island has very little coral and behind the shore line a sandy alluvial plain rises gently to the foothills of the Crown Prince range about 4000 yards inland. Near the shore are some lagoons and in the region of the Toro-kina River extensive swamps. The subsoil of the plain is black volcanic sand providing good drainage. The rainfall which is fairly uniform throughout the year averages approx-imately eleven inches per month. Heavy tropical showers are characteristic while [illegible] the hillsides and make constant road maintenance a necessity.



Fig 1:

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The Japanese capture of Guadalcanal was Virgin jungle except for a small coconut plantation on Lunga Point. The elaborate system of roads shown in the accompanying terrain map was all cut and built since the initial landing during the first week of November 1942. At the time of the enemy attack on 24 March 1943 this system of roads was nearly completed except for a section of the perimeter road connecting the Matanikau and 27th Division sectors. The perimeter at its greatest depth was carried around the hill ridges of the foothills and this extremely rugged terrain presented a major problem in evacuation. Where roads were not present or were under fire. This road system alone played an important role in saving the lives of many casualties which might otherwise have been lost. However, the problem of evacuation of casualties within the perimeter was simple when compared to the difficulties encountered in evacuating casualties on patrol. A description of such difficulties given by Major William T. Calloway, regimental surgeon of the 164th Infantry, 23rd Division, is included in Appendix 1. Patrols constantly covered this rugged terrain beyond the perimeter for distances of 500 to 6000 yards. Even a 1000 yard carry over these ridges and draws was exhausting to both the litter bearers and the patient.



Fig. 1: View looking from Edson Ridge, towards the Lunga River area, located just north from the Henderson airfield. The ridge was used by the artillery positions in their attack on Tokyo. In the distance is Lunga Point, the airfield and Guadalcanal Island.

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Fig.3: Aerial view of approximately half of the perimeter. Sector held by 37th Division left and Americal Division right.

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b. Medical Installations and Routes of Evacuation

The medical installations and routes of evacuation were better developed on Bougainville at the time of the attack than for any other Island campaign in the South Pacific. This was due to the fact that the beachhead had been developed steadily over a period of four months before the battle of the perimeter began.



Fig 4: One of the routes of evacuation between the Clearing Station of the Americal Division and the 21st Evacuation Hospital.

Two way all weather roads made all parts of the perimeter easily accessible with one exception. This one sector lay near the boundary line between the Americal and 37th Divisions, where the perimeter road had not been completed. Furthermore, the roads were kept open throughout the battle except on Hill 700. Here the one way all weather road over very rugged terrain leading to the hill was for a time under enemy fire and as a result a difficult litter carry of 1200 yards was necessary during the attack. Later at this point and at others where sporadic fire was encountered, half tracks were used for evacuation, patients then being transferred to jeep ambulances and taken to the hospital. The greatest distance from the front line to a clearing station was found on the Americal sector at the mouth of the Torokina River which was approximately 10,000 yards over a good road.

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Fig 5: A section of the perimeter road behind the 145th Infantry, 37th Division.



Fig 6: Perimeter road near junction of Americal and 37th Divisions. A good route of evacuation over difficult terrain built by the 117th Engineers.

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Owing to this excellent system of good roads, the majority of patients arrived at the hospitals within three hours, and frequently within an hour. A sample of 142 patients showed that 87 per cent were on the operating table within three hours. Patrol missions presented the most difficult problems of evacuation. Small patrols, frequently no larger than a platoon, were so numerous that it was impractical to send a medical officer with each one. Larger combat patrols were usually accompanied by a medical officer. On only one occasion was a patrol large enough to warrant the use of a portable surgical hospital. As a consequence some patients who were wounded on patrol did not reach the hospital until twenty four to forty eight hours had elapsed. However, every effort was made to reduce delay to the minimum, and to provide surgery at the earliest possible moment.



Fig 7: Roadway along the Laruma River. This was outside the perimeter.

The medical installations available for this campaign were more than adequate. The clearing stations of both the Americal and 37th Divisions had been augmented with additional surgical equipment before the hospitals were established on the beachhead. The 31st Portable Surgical Hospital had been assigned to the Americal Division and the 33rd Portable Surgical to the 37th Division. Owing to the fact that more adquate medical facilities became available later, the portable surgical hospitals were not necessary although they were both utilized. (See Map Fig.11). The 52nd Field Hospital was utilized for the

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Fig 8: Ward area of the 21st Evacuation Hospital on Bougainville.

care of service troops and functioned chiefly as a station hospital for the Island. The 21st Evacuation Hospital, an affiliated unit from the University of Oklahoma, had an exceptionally well qualified staff including the various specialists. The construction of this hospital was completed on 8 March 1944, although it had been functioning for a limited number of patients since the 15 February. Its normal capacity was 750 beds with facilities available for an additional 250 beds. Casualties from all combat troops were cared for at this hospital. Since the 21st Evacuation Hospital was situated only 4,000 yards from the front lines at the nearest point of attack (forward of some artillery batteries), the majority of the seriously wounded patients were sent directly to the hospital to avoid delay at the clearing stations.

All patients from the Island were evacuated through the 21st Evacuation Hospital. Nearly all patients evacuated to the rear were sent by air transport to Guadalcanal and were cared for there in one of three 500 bed station hospitals. Patients requiring a long period of convalescence were evacuated from this Island by ship or air transport to Espiritu Santo and to New Caledonia.



Fig 9: Underground operating room of the 21st Evacuation Hospital on Bougainville. There was another similar operating room above ground providing space for eight tables.



Fig 10: Interior of underground ward, 21st Evacuation Hospital on Bougainville. Space was provided for 120 litter patients underground. This would have been inadequate if shelling had been heavy.

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Fig 11: An underground operating room of the type used by the portable surgical hospitals.

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LEGEND of ROAD NET

Two-way, all-weather road

One-way, all-weather road

Jeep trail

Foot trail

12 A

c. Allied and Japanese Forces

(1) Allied Forces on Bougainville were concentrated in the Empress Augusta Bay beachhead. The perimeter line of defense had been extended previously in three phases until by the time of the Japanese attack on 8 March 1944, it enclosed about twenty square miles and was approximately 22,000 yards in length.

The total strength within this perimeter as of 31 March 1944 was 60,583. Included were 11,220 Navy personnel, Marines and civilians. The casualties from these groups are not included in this study although they were few and due mostly to shelling and bombing. The casualties included in this study were derived, therefore, from a total strength of 49,363. Of this number 40,404 were U. S. Army ground force combat troops of which 27,831 constituted the 37th and Americal Divisions. The remainder of the ground force combat troops were attached to the XIV Corps and the 25th Regiment Combat Team. Allied forces other than U.S.troops, chiefly Royal New Zealand Air Force and Fijian Infantry, numbered 3,424.

It should be noted that of the above forces, the number involved in combat was comparatively few. The number actually involved could not be ascertained except for certain specific engagements to be described later. The perimeter line of defense was divided between the 37th and Americal Divisions although other forces were used in the line at various times. The Fijian troops, among whom there were a considerable number of casualties recorded in this report, were used chiefly on patrol missions.

(2) Japanese Forces.

Immediately prior to the attack, the effective strength of the Japanese Army and Navy forces on Bougainville numbered about 27,000. Of these about 18,000 were believed to be Army combat troops. The remaining strength consisted of Army and Navy antiaircraft, base, service, and labor troops. No surface ships had been observed in the Bougainville area since mid-November 1943, and whatever supplies were brought in were carried by submarine or barge. There is evidence that the enemy was short of supplies except small arms ammunition.

Although elements of the 17th Division (one battalion each from the 81st and 53rd Infantry Regiments) were identified in the Torokina area, the brunt of the attack was borne by the Japanese 6th Division. The backbone of the enemy's strength was the 13th, 23rd, and 45th Infantry Regiments. These units were supported by the 6th Field Artillery Regiment (2nd Battalion) elements of the 4th Heavy (Medium) Artillery Regiment, as well as miscellaneous mortar, artillery, engineer and road construction units. (See Fig.13). The first Battalion, 13th Infantry (-1 co.) was to be the division reserve. The total strength of these units actually in combat in the battle of the perimeter was believed to be only slightly more than 10,000.

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The enemy forces faced great difficulties of transportation on the Island in maneuvering various units, especially heavy artillery, into positions favorable for attack. This had to be accomplished over the most rugged type of terrain at great expenditure of man power. Finally they attacked with almost no air support.

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MAP NO. 1

EMPRESS AUGUSTA BAY
BOUGAINVILLE ISLAND
SOLOMON ISLANDS GROUP
A.C. OF S. G-2
HQ USAFISPA
CARTOGRAPHIC UNIT
MARCH 28, 1944 A-1086

DISPOSITION – 26/FEB/1944
PLANNED MOVEMENT

0 1000 2000 3000 4000 5000 6000
YARDS

LEGEND
TWO WAY ALL WEATHER ROADS
JEEP ROADS
ONE WAY ROADS
TRAILS

DISPOSITION OF PRINCIPAL ENEMY UNITS. 29/FEB/1944


230
120
125
130
135
140
145
225
220
215
210
Atsinima River
ATSINIMA BAY
TO HOUSE MAP
Laruma River
MAIN EFFORT MAR. 12-24
75 YDS. PENETRATION MAR 17
BLUE RIDGE
MAIN EFFORT MAR. 9-12
TRAIL CONNECTING WITH NUMA NUMA TRAIL. EXACT LOCATION UNKNOWN
LAKE KATHLEEN
CARR'S HILL
1000
1111
700
600
250
280
SNUFFY'S NOSE
MT. BAGANA
ACTIVE VOLCANO
Koramokina River
KUGUBIKOPAI-IA
MAIN EFFORT MAR 9-12
Eagle River
Taros River
EAST-WEST TRAIL
PEKO
PIVA NO 1
MOPARA
PATROL CLASHES
309
270
280
185
188
300
130
301
Piva River
PIVA NO 2
Torokina River
NOTE NATIVES REPORT TRAIL 7'-8' WIDE FROM PEKO TO KOIARIS
PURUATA
BURETONI MISSION
PURUATA IS.
TOROKINA IS
Cape Torokina
Saua River
Reini (Koiari) River
EMPRESS AUGUSTA BAY
Mavovia River
PATROL CLASHES
MAVAVIA
Moy River
MAGINE IS.
KOIARIS
MAP NO 2
EMPRESS AUGUSTA BAY
BOUGAINVILLE ISLAND
SOLOMON ISLANDS GROUP
A.C. OF S. G-2
HQ USAFISPA CARTOGRAPHIC UNIT
MARCH 26, 1944 A-1086
0 1000 2000 3000 4000 5000 6000
YARDS
LEGEND
TWO WAY ALL WEATHER ROADS
JEEP ROADS
ONE WAY ROADS
TRAILS
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d. A Description of the Weapons Commonly Employed by the Japanese at Bougainville.

In the period under study Japanese weapons accounted for 1569 casualties. Six hundred and fifty nine (42.0 per cent) of these were produced by mortar fire. There were 393 (25.1 per cent) who were killed or wounded by rifle fire. Of the remaining casualties the grenade was responsible for 205 (13.1 per cent), machine gun for 151 (9.6 per cent), artillery for 151 (9.6 per cent) and miscellaneous weapons for ten (0.6 per cent).

(1) Rifles

Estimates based upon captured weapons indicate that the ratio of the 6.5 mm to the 7.7 mm rifle was approximately four to one. Furthermore, of the smaller caliber (6.5 mm) weapon, roughly 90 per cent were "long", 7 per cent "short" and 3 per cent "medium" types.

Designed by Arisaka the model 38 (1905) 6.5 mm rifle, listed by the Japanese as "Sampachi Shiki Hoheiju" is commonly called by them the "Arisaka Sampachi". Patterned after the mauser type, this weapon possesses an action resembling the U.S. caliber .303 M 1903 (Springfield) rifle. Loading is accomplished by a five round clip. The muzzle velocity is 2,410 feet per second, the effective range 400 yards, and maximum range 2,600 yards. This weapon without sling and bayonet weighs 9¼ lbs. The almost complete absence of muzzle flash is a characteristic commented upon favorably by our soldiers. Since the latest Japanese rifle, model 99 described below, does not possess this feature it is apparently considered unimportant by the enemy.

The later but less common model 99 (1939) 7.7 mm rifle is designated by the Japanese "kyukyu Shiki Tanshoju". Like the previous model 38, this weapon has a manually operated bolt action and a magazine capacity of five rounds. Unloaded and with sling this rifle weighs 8½ lbs. The muzzle velocity of this weapon is 2,300 feet per second, the effective range 600 yards and the maximum range 3000 yards.

(2) Machine Guns

Most commonly employed by the enemy at Bougainville, in a ratio of approximately four to one, were the model 96 (1936) 6.5 mm light and the model 92 (1932) 7.7 mm heavy machine guns. Extremely rare was model 11 (1922) 6.5 mm light ("nambu Keiki") among the 200 captured machine guns.

Closely resembling the British Bren light .303 caliber model, the model 96 (1936) 6.5 mm light machine gun is considered an excellent weapon by our officers. ("I have never heard it jam".) The Japanese name for this weapon is "kyuroku Shiki Keikikanju". Weighing only 20 lbs., it is easily handled and may be fired from the hip. It is a gas operated, air cooled weapon, fed by curved-box magazine containing thirty rounds. The cyclic rate of fire is 550 rounds per minute. Its muzzle velocity is 2,410 feet per second, effective range 1,640, and maximum range 4,374 yards.

Model 92 (1932) 7.7 mm heavy machine gun is officially designated by the Japanese "Kyuni Shiki Jukikanju", but commonly called by them "Juki". Its slow rate of fire (effective 200, cyclic 450 rounds per minute) almost entirely eliminates overheating. It weighs with tripod 122 lbs. A modified Hotchkiss-type weapon, it is gas operated, air cooled, and fed by brass strips containing thirty rounds. Three telescopic sights are available. The effective range is 1,500 yards, and the maximum range is 4,587 yards. The muzzle velocity is 2,400 feet per second.

(3) Mortars*

Wounds ascribed to the mortar at Bougainville in many instances were actually produced by the grenade discharger. Mistakenly called the "Knee Mortar", this weapon, because of its accuracy and efficiency has earned the respect of the American combat troops, and is more feared than any other Japanese weapon. If the "Knee Mortar" is grouped with the other types of captured mortars it is found to constitute approximately 90 per cent of the total. The ratio of the 81 mm to the 90 mm mortar (both models) was about three to two. A total of 96 mortars were captured, only one of which was the 90 mm model 97 (1937).

There are two types of the 50 mm grenade discharger; the smaller model 10 (1921), and the larger model 89 (1929). Model 10 has a smooth bore barrel, nine and one half inches long, an overall length of twenty inches, and weighs 5¼ lbs. Using the model 91 grenade its range is 65 to 175 yards. The barrel of model 89 is rifled and measures ten inches in length. The overall length is twenty four inches and the weight 10¼ lbs. Maximum range for this weapon is 770 yards with the model 89 shell, and 175 yards with the model 91 grenade. The range of this weapon depends upon the distance travelled by the projectile through the barrel. This distance is regulated by increasing or decreasing the length of the trigger housing extending inside the barrel of the discharger. The weapon is thought to operate most efficiently at an angle of 45°, its base resting on the ground or some solid structure. With model 89 projectile, the effective range of burst probably is five to ten yards, and the danger zone about forty yards.

Both 81 mm and 90 mm mortars were in common use at Bougainville. Very little information is available regarding model 97 (1937) 81 mm mortar. It closely resembles the U.S. 81 mm mortar M1, and it is said that shells for the two weapons can probably be used interchangeably. The Japanese name for this mortar is "Kyunaua Shiki Kyokusha". The effect of the shell is that of blast and fragmentation with an estimated effective range from the burst if fifteen to twenty yards, and a surrounding danger zone of 200 yards.

Model 94 (1934) 90 mm mortar (marked "kyuyon Shiki Keihakugekiho") fires both chemical and high explosive

- -

* See Appendix II Frequency Distribution of Shell Fragments from Japanese Mortar Shells.

shells. It is a smooth bore, muzzle loading weapon with a maximum range of 4,150 yards. It weighs 340 lbs. From point of burst the shell has a probable effective range of twenty yards and a danger zone of 300 yards.

(4) Grenades

Because it can be thrown by hand, fired from a grenade discharger, or used as a rifle grenade, model 91 (1931) hand grenade, "Kyuichi Shiki Shuryudau" is a useful, versatile and frequently employed weapon. Made of cast iron and painted black, it is distinguished by the serrated surface, brass safety cover and perforated propellant container screwed into the base. When used as rifle grenade, a tubular tail fin is substituted for this propellant container. The grenade weighs 18.8 ounces, is 3.75 inches long without the propellant container, and measures 1.97 inches in diameter. When used as a hand grenade, the propellant container is, of course, unscrewed and removed. Model 97 (1937) hand grenade is similar to model 91 except that it has no propelling charge, and cannot be fired from a grenade discharger. It is carried by all Japanese front line troops. This grenade is loaded with TNT and weighs one pound. It may be used as a booby trap. It is said to have poor fragmentation, the fragments being small and of short range. The effective range from the burst is estimated at five yards and the danger zone thirty yards.

(5) Artillery

Artillery support in the plan to neutralize and seize the three Torokino airfields was the most extensive yet employed by the enemy in the South Pacific. Through dense jungle and over exceedingly rough terrain to positions overlooking our perimeter, the Japanese were able to transport a considerable number of heavy weapons. Assuming all units at full strength, an order of battle indicates that the maximum number of weapons available to them was 136. Actual observation suggested the presence of approximately forty or fifty pieces.

With the exception of the 10 and 15 cm pieces all weapons were of pack type and were undoubtedly carried by hand. Possibly the 150 mm howitzers may have been dismantled also, as some of these were reported on Mt.Bagana. These weapons were brought by water to Koaris and thence by road to the vicinity of hills 500 and 501. Limited use of horses was reported on the Kahili-Empress Augusta Bay track. Apparently there was no serious shortage of ammunition by Japanese standards, fire having continued intermitently from some positions for three weeks. Considerable quantities of ammunition were generally found with the captured weapons.

Principal targets were the air strips, supply, and CP areas, road junctions and the tank area. Massing of fire was not utilized, gun fire seemed independent. The heaviest concentration occurred in the early morning and evening. On 23 March in less than two hours, seventy rounds

fell on the Piva Airfields. After the first two days of attack, during which some parked planes were destroyed, rarely in a single day did more than five in six shells fall on these same airfields.

Difficulties inherent in jungle warfare precluded the use of artillery in close support of attacking Japanese infantry. For this purpose they relied principally upon 90 mm mortar fire.

The Japanese employed at least thirty five 75 mm guns model 41 (1908) and model 94 (1934), the former predominating. These pieces were situated north and northeast of the perimeter. Four 150 mm howitzers were located on the northeast and east, and two 105 mm howitzers on the east near hill 501. Mortar fire received was principally from the north and northwest sections. The greatest concentration of fire in any one day was 200 rounds. In contrast to the experience during the weeks after the landing in November, the proportion of "duds" was remarkably low. Observers were able to identify by type of burst or by "duds" about 1300 rounds received. Of these 885 were 75 mm shells and 130 were 150 mm shells. Many types of artillery weapons were captured. The five most common models will be described briefly.

Model 94 (1934) 37 mm gun is designated "Kyuyon Shiki Sanjunana Miri Ho", and commonly called "Sanjunana Miri Ho". It can be used both as an anti-tank and anti-personnel weapon, employing armor-piercing, high explosive and shrapnel ammunition. This gun has a long slender barrel measuring 66.5 inches in length. The effective range is 2,500 yards, and the maximum range 5,000 yards. The total weight of the weapon in action is 714 lbs. The effective burst of the high explosive shell is said to be ten yards with a zone of danger extending about seventy five yards. Fragmentation tests have shown that the 500 grams of metal in the shell broke into 490 fragments. Only 143 of these fragments were classified as lethal (average weight of lethal fragment being 3.1 grams). Assuming that all fragments passed within a mans height standing at seventy five yards, it is estimated that his chance of being hit would be 50/50. This assumption is incorrect, however, the actual chance being 1 in 100. Nevertheless, this hit could be fatal.

The model 92 (1932) 70 mm howitzer (battalion gun), "Kyuni Shiki Hoheiho" is a horse drawn infantry support howitzer. It weighs 468 lbs. and can be handled by a ten man section. It has an effective range of 1500 yards and a maximum range of 3,000 yards. The estimated effective range of burst is twenty yards and the area of danger is 200 to 300 yards.

Now issued for use as an infantry regimental gun, the model 41 (1908) 75 mm mountain (infantry) gun was originally used as a field artillery pack gun. The effective range of this weapon is 2,100 yards and it fires both high explosive and armor-piercing shells. With the long pointed shell its maximum range is 7,675 yards, and with

the ordinary shell 6,575 yards. The total weight is 1,200 lbs. Its muzzle velocity is listed as 1,200 feet per second. The effect is produced both by blast and fragmentation. The shell has a probable effective burst of twenty yards with a danger zone of 300 yards.

The model 96 (1936) 150 mm mobile field howitzer has a range of 13,200 yards. The effective range of the shell burst is said to be fifty yards with an area of danger of 500 yards. The effect produced is that of blast and fragmentation.

The model 98 (1938) 20 mm anti-aircraft anti-tank machine cannon is an all purpose weapon. It is gas operated and semi or full automatic. The ammunition for this weapon is high explosive, tracer and armor-piercing, and is fed by a 20 round box magazine. This weapon is very maneuverable, weighing without wheels 836 lbs. The rate of fire is 120 rounds per minute. The muzzle velocity is 2,720 feet per second, and the maximum ranges, horizontal 5,450 and vertical 12,000 feet.

A list of Japanese weapons captured on Bougainville follows:

RIFLES

*Model 38 (1905) 6.5 mm Rifle (Long)
Model 38 (1905) 6.5 mm Rifle (Short)
Model 97 (1937) 6.5 mm Snipers Rifle
Model 38 (1905) 6.5 Rifle (Medium)
Model 44 (1911) 6.5 Cavalry Carbine
*Model 99 (1939) 7.7 mm Rifle

(Caliber Equivalents 6.5 mm - .256 inch, 7.7 mm - .303 inch)

MACHINE GUNS

Model 11 (1922) 6.5 mm Light Machine Gun ("Nambu")
*Model 96 (1936) 6.5 mm Light Machine Gun
Model 99 (1939) 7.7 mm Light Machine Gun
*Model 92 (1932) 7.7 mm Heavy Machine Gun

MORTARS

*Model 97 (1937) 81 mm Mortar
*Model 94 (1934) 90 mm Mortar
Model 97 (1937) 90 mm Mortar
*Model 89 (1929) 50 mm Grenade Discharger ("Knee Mortar")

GRENADES

*Model 97 (1937)
*Model 91 (1931)
Model 23 (1923) Booby Trap Grenade

ARTILLERY

*Model 94	(1934)	37 mm Gun
Model 1	(1941)	47 mm Gun
*Model 92	(1932)	70 mm Howitzer (Battalion Gun)
*Model 41	(1908)	75 mm Mountain (Infantry) Gun (or Regimental Gun)
Model 94	(1934)	75 mm Mountain Gun
Model 91	(1931)	105 mm Light Field Howitzer
*Model 96	(1936)	150 mm Mobile Field Howitzer
Model 97	(1937)	20 mm Anti-Tank Rifle
*Model 98	(1938)	20 mm Anti-Aircraft-Anti-Tank Machine Cannon.

* Asterisk indicates models most frequently employed. In this section free reference has been made to "Japanese Infantry Weapons", special series No.19, prepared by Military Intelligence Division, War Department.

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3. BRIEF NARRATIVE OF THE BOUGAINVILLE CAMPAIGN DURING THE PERIOD COVERED BY THIS REPORT (15 FEBRUARY TO 22 APRIL 1944.

a. The beachhead was established during the first week of November 1943. The period prior to the battle of the perimeter was characterized by consolidation of the defenses of the airfields which were being used in attacking enemy installations in the Bismarck Archipelago and on Bougainville. By 15 February the air strips were completed and the perimeter established with the 37th Division on the left flank and the Americal Division on the right flank. From 15 February to 8 March the perimeter defense was strengthened, and an extensive system of roads was further developed within the perimeter. During this period patrols made contact with enemy forces moving into position north and east of the perimeter. Some artillery installations were discovered and strong enemy positions were noted on Hills 1000, 1100, and 600 east of the Torokino River mouth. However, during this period contact with the enemy was limited to patrol skirmishes and an occasional bombing raid at night.

b. The battle of the perimeter extended from 8 March to 24 March. The Japanese laid plans for this offensive sometime around the turn of the year. Our intelligence obtained information that the enemy attack was to be launched on the 8 or 9 March, thereby permitting ample preparation for defense of the perimeter.

(1) Enemy Plan. The three infantry regiments were to leave their respective lines of departure (see Sky Fig. 13) following an artillery barrage. This barrage was to commence at 0430 Y day from the main strength of the 6th Artillery Regiment located near Blue Ridge (Mountain Guns) and the Medium Field Artillery (10 and 15 cm field pieces) deployed near Hill 500. It appears that the 45th Infantry was to constitute the main thrust and were to strike our forces near the point where the Piva-Numa-Numa road enters the perimeter. (129th Infantry Sector). Simultaneously the 23rd Infantry was to launch its attack from approximately 1000 yards N.E. Hill 700 with the 3rd Battalion on the left and the 2nd Battalion on the right and the 1st Battalion in reserve. By the end of Y day the 3rd Battalion was to have captured Hill 700 and the 2nd Battalion was to have occupied Cannon Hill. These heights overlooked the Piva air strip and the main strength of the 23rd Infantry was to have attacked the strip from the East while the 45th attacked from the West. The 13th Infantry was to attack Hill 260 and then join with elements of the 23rd Infantry to proceed in the general direction of the strip. These three main thrusts are shown on the map (Fig.14) and on the aerial photograph (Fig.3).

(2) Results. The enemy's Torokina operation began on 8 March with preliminary artillery fire directed mostly on the Piva air strips. Blue counter fire against hostile positions located in the general areas of Hills 1111 and 501 began immediately. The main Japanese drives began under the cover of darkness during the night of 8 and morning of 9 March at the three points on the perimeter

indicated on the map (Fig.3). In the East sector patrol contacts and fire fights took place in the vicinity of Hill 260. To the North on Hill 700 the Japanese infiltrated through our lines and occupied the northwest slope of the hill. Blue counter attack reduced the Japanese positions and the perimeter was reestablished. In the Northwest sector several fire fights occurred. The Japanese had occupied strong points on Hill 260 and severe fighting resulted in retaking these points but by 11 March two Blue companies occupied Hill 260 with the exception of strong points on the southeast slope. Another attack on the Northern sector was repulsed. Meanwhile preparations for an enemy drive from the Northwest continued. On the 12 March three major attacks from the Northwest near the Numa Numa Trail placed the Japanese within our perimeter. Our tank-infantry teams reestablished the lines the next day. The same Blue forces on Hill 700 received and repelled the third attack on that position. On 15 March another attempt was made by the Japanese to break through the sector held by the 129th Infantry. Tank-infantry counter-attack again restored the perimeter. The next strike by the enemy was again from the northwest near the Piva-Numa-Numa Trail on 17 March. Although a seventy five yard penetration was made for the third time, tanks and infantry drove the enemy back. For a week the Japanese remained relatively quiet regrouping their forces opposite the northwest sector of the perimeter. Smaller holding forces which were dug in were contacted on the other sectors. On 24 March after a feeble attempt at laying an artillery barrage, the Japanese struck toward the Piva air strips once more, penetrated the 129th Infantry lines and again were driven back, losing 300 men and a field gun. On each occasion when penetration was made the enemy succeeded in occupying pill-boxes within our perimeter only to be dislodged with heavy losses.

c. The Japanese did not again attack in force after the repulse on 24 March and began a general withdrawal. However, Hill 260 was not evacuated by the enemy until 28 March. From 28 March to 22 April when this study was completed, contact with the enemy was limited to a few fire fights, patrol skirmishes and occasional shelling of the air strips. There were 5522 Japanese dead counted between 8 March and 22 April. However, this did not include all areas subjected to our artillery fire.

4. BATTLE OF THE PERIMETER
(Description of three major attacks).

a. Operations on Hill 260 *

(1) The original garrison on Hill 260 - a reinforced platoon from Company C was attacked by a Japanese force of undetermined size at dawn on 10 March. The enemy generally occupied the area south of the CP tree and from this date until the termination of the battle, the Japanese tried to increase their garrison and improve their positions on that side of the hill in order to secure observation for an all-out attack on the main line of resistance.

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*Extracted from report by Lt.Col. Wm.J.Mahoney, Executive officer, H. & S.182nd Infantry, Americal Division.

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Fig.15: Jungle growth on Hill 260 showing protection afforded by trees.

(2) Forces engaged: American: B, E, F, G, and H Companies plus one platoon of K, 182nd Infantry, and Co. G, 164th Infantry, actively took part in the action on the hill. All other companies in the regiment were in general support plus A and B Companies, 57th Engineers; 246th and 247th FA Battalions; 82nd Chemical Battalion. Total 1350 men.

Japanese: Elements of the 13th and 23rd Infantry regiments, both part of the 6th Division, have been identified as taking part in the battle for Hill 260. It is estimated that 1400 Japanese were involved in this action.

(3) After the initial attack, the Japanese held the south end of Hill 260. They greatly increased the force which made the original attack because they beat back our every attempt to storm the northwest, southwest and southeast ridges of the hill during the period 11-17 March. Apparently their main route of supply and evacuation was down the steep east side of the hill, then north clinging to the east side of the west bank bluff overlooking the Torokina River. This route was well-concealed and in defilade and difficult to reach by fire. After the initial engagement reinforcements were sent to secure the north side of Hill 260. The establishing of a perimeter there and the continual pressure on the Japanese positions completely neutralized the effect of the offensive action taken by the Japanese. The possession of Hill 260 by the enemy would have jeopardized a considerable portion of our main line of resistance.

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Fig.1o: These trees are common in the jungle on Bougainville and offer excellent protection. The OP tree on Hill 260 was of this variety.

(4) From the outset, the problem on Hill 260 was one of ejecting the Japanese from the south end of the hill. Their positions were well dug in and defended and various American assaults to take the hill were turned back with heavy casualties. Artillery and mortars were useful in blasting Japanese positions in the general area but due to the proximity of our own troops, prepared fires could not be used on the Japanese positions just outside our perimeter. Artillery was effective on the exposed southwest slope and after a week's fighting, the Japanese were pretty well removed from that area. But those in defilade on the southeast slope dug in and countered our every move. Various means were used to force the Japanese from their dugouts during the closing ten days of the battle. It was obvious that at that time the Japanese garrison was considerably reduced in numbers although there was not a corresponding lessening of fire power. Flame-throwers and gasoline ignited with thermite grenades reduced a few pill-boxes. As late as the morning of 28 March Japanese were seen near pill-boxes on the southeast slope. On the morning of 28 March, three patrols were sent around the base of the hill to fire on the Japanese. When there was no fire, our patrols investigated and found that the Japanese had evacuated. At 1246, 28 March, Hill 260 was secured. On the morning of 30 March, the 2nd Battalion, 182nd Infantry, was replaced on the hill by 1st Battalion 24th Infantry.

(5) Estimates of Japanese killed and wounded were difficult to make because of their practice of carrying away and burying their own dead. A total of 212 Japanese bodies were found by our troops on Hill 260 and the Americal Division G-2 listed 541 Japanese as the total killed.

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Fig.17: Focal point of entire Hill 260 battle. Banyan tree used as an Americal Division Artillery spotting post. 541 Japanese were killed in the 20 day fight for the hill. This tree is similar to those in Fig.16 and withstood artillery shelling and fire.

In addition many wounded were seen going to the rear and it is believed an entire battalion plus a number of supporting troops were virtually wiped out. The heaviest fighting occurred during the period 10-14 March and as indicated later by POW reports, this engagement broke up the initial attack of the entire Japanese 13th Infantry Regiment on the Bougainville Island perimeter.

(6) The terrain was that of an elongated hill with moderately steep sides covered by rain jungle. The OP tree (Fig.17), around which the heaviest fighting occurred, was one of a common variety of trees on Bougainville, the roots of which plus excavation make a very strong defensive position.



Fig.18: Hill 260 on March 19 being blasted by Americal Division artillery fire. The firing continued for several hours at the end of which time it was believed that all enemy resistance had been neutralized. Partial destruction of jungle growth may be seen.

In comparison to the other two main thrusts by the enemy on the perimeter there was more offensive action by our troops on Hill 260. The enemy in the initial attack had captured and managed to defend the OP tree which was the focal point on the hill. Furthermore, the character of the terrain lent itself readily to defense and prevented the effective use of tanks.

(7) During this engagement our casualties were as follows:

KIA		SERIOUS		NON-SERIOUS		MIA		TOTAL		AGGREGATE
O	EM	O	EM	O	EM	O	EM	O	EM	O & EM
8	63	9	204	37	370	4	18	58	655	713

There were approximately 1350 of our troops involved or 52.8 per cent casualties with 5.3 per cent killed in action. Ratio of Japanese to our troops killed was 7.6 to 1.

The heaviest casualties were in the 182nd



Fig.19: Enemy pillbox on Hill 260. The dense jungle growth has been entirely cleared away by artillery fire.

Infantry with 800 troops involved:

Killed in Action	63	or	7.9 per cent
Seriously Wounded	106	or	13.3 per cent
Slightly Wounded	256	or	32.0 per cent
Self-inflicted Wound	1	or	0.1 per cent
Total Casualties			53.2 per cent

b. Operation on Hill 700*

(1) The terrain here was mountainous but mostly second growth rather than virgin jungle. The sides of the ridges were very steep and at one point of the assault was almost precipitous. The action by our troops was largely defensive involving, however, the recapture of certain positions into which the Japanese had infiltrated. A one way road leading along behind our lines for a time was under enemy fire, necessitating a difficult carry for the litter bearers of more than a thousand yards.

(2) On the morning of 8 March the Japanese attack began with some artillery and spasmodic small arms fire which continued throughout the day. During the night of 9 March booby traps warned of attack followed by hostile fire from mortars and rifles. At dawn it was found that

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* Extract from G-3 Periodic Report, H.Q. 37th Infantry Division.



Fig.20: Jungle growth partially cleared on Hill 700. Through this draw the Japanese made their approach to the Hill.

at least one company of Japanese had occupied the north slope and crest of Hill 700 and had penetrated our line to a depth of 75 yards over a 100 yard front. During the day a counter attack by the 1st and 2nd Battalions of the 145th Infantry regained several pillboxes on the south slope of the hill. One tank was used with fair success along the road which was under fire. On 10 March the enemy retained possession of the crest of the hill in spite of continued ground action. Efforts to reach the Japanese positions on Hill 700 by engineer "polecharges", bangalore torpedoes and bazookas were without avail and resulted in numerous casualties due to the excellent Japanese field of fire.

At 1700 hours 10 March a determined attack was made by our forces and, in spite of intense enemy light and heavy mortar and artillery fire, succeeded in driving the enemy from the crest of Hill 700. Japanese concentrations coming up to reinforce this area were subjected to heavy bombing and artillery fire which was very effective. On 11 March at daylight the enemy made a general assault on Cannon Hill held by the 3rd Battalion of the 145th Infantry. The attack was repulsed with the exception of one pillbox gained by the enemy on Hill 700. Japanese losses were reported as enormous with the enemy assault wave attacking over piles of their own dead. On 12 March after severe fighting our forces succeeded in driving the enemy from Hill 700. Three hundred and ninety nine Japanese dead were counted within the wire on the crest and on the forward slope of the hill. On the night of 13 March the enemy

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Fig.21: Precipitous hillside off the perimeter road. - Grenades were rolled down this bank causing many casualties.

again attacked in the draw west of Hill 700. Searchlights were used successfully to reflect light from the overhanging clouds and the attack was repulsed. After this date only intermittent contact was made with the enemy in this area.



Fig.22: Wounded soldier being helped down the side of Hill 700 by two medical corps men.



Fig.23: Wounded transferred from half-track to jeep. Half-track was used because road was under fire.



Fig.24: Enemy dead who were blasted to bits while defending their position in a pillbox on Hill 700.



Fig.25: Interior view of Jap 75mm gun emplacement on Blue Ridge that was used in their attack on Hill 700. Note the large window.

(3) U.S.Forces involved		2600	
Killed in Action	45		
Wounded in Action and Died later	16		
Dead		61	- 2.4%
Wounded in Action (to duty)	215		
Wounded in Action (hospitalized)	243	458	- 17.6%
Total Casualties		519	- 20.0%
Japanese Killed in Action (Counted)		719	
Japanese Killed in Action (Estimated)		1500	
Japanese Total (Dead)		2219	
Ratio of U.S.Dead to Japanese Dead		1 to 36	

The large number estimated rather than counted is due to the enemy custom of burying several bodies in one grave,

and also to the large number killed by our bombing and artillery fire behind the lines, making it impossible to obtain an immediate count.

c. Operations on 129th Infantry Sector*

(1) The terrain here was fairly flat covered with second growth and provided fair ground for tank maneuvers. The action here was characterized by temporary withdrawals from forward positions under the pressure of Japanese attacks followed by highly effective tank supported counter attacks.



Fig.26: Action on 129th Infantry Sector showing cleared area of jungle in front of perimeter.

(2) On 6 March there were numerous patrol contacts and clashes with superior Japanese forces advancing along the Laruma River and our outposts were forced back. The main attack by the 45th Japanese Infantry was launched on the morning of 12 March which succeeded in penetrating our wire and occupying several pillboxes, some of which were retaken by counterattack. Again, in the early morning of 13 March the enemy attacked taking six more pillboxes

* Extracted from G-3 Periodic Report, H.Q.37th Infantry Division.



Fig.27: Firing at the enemy with concentrated rifle and grenade fire. Soldier at right-center has just tossed a grenade. Action is at last pillbox on left flank of the perimeter of Co F, 129th Infantry, 37th Division.



Fig.28: Action during San Antonio Campaign, 129th Inf. 37th Div. Scene here is at area of CP. Reinforcing troops of Co A are in prone position as an enemy machine gun grazes the area. Tanks in background were called upon to knock out enemy positions. Burning jeep is the result of a Jap grenade.



Fig.29: Soldiers of Co F, 129th Infantry, 37th Division crawling up to barbed wire. Japanese were just in front and to left of wire and occupied one of our pillboxes to the left and one to the right of picture. Our troops were surrounded until tanks were called upon to knock out the enemy.

and again counter attacks supported by tanks succeeded in retaking all but two pillboxes. The Japanese were attacking very strong positions in relatively open terrain and their losses were heavy, estimated at 350-500 dead on this day, compared with two killed and ten wounded in the 129th Infantry sector. 14 March was a relatively quiet day during which our wire was repaired under cover of the tanks. On 15 March at 0400 hours the Japanese again attacked and, after heavy fighting, penetrated to a depth of 100 yards over a 1000 yard front. A tank-supported counter attack failed to dislodge the enemy who had now brought in at least one 77 mm Field gun. A second counter attack, supported by tanks and a heavy concentration of artillery, reestablished our line. 16 March spasmodic fire occurred but on 17 March at 0400 hours the enemy again attacked, breaching our wire to a depth of 75 yards where the attacks stopped and the enemy dug in. Prisoners statements indicated that our artillery had taken a huge toll in the support and reserve units. Our artillery continued a heavy harassing fire and except for sporadic fire fights the sector was relatively quiet until 24 March when shortly after midnight the Japanese began to infiltrate. By daylight the enemy had penetrated 300 yards. During the day there was heavy hole to hole fighting and tank-supported



Fig.30: Light tank of the 754th Tank Battalion in action against the Japanese at Co C, 129th Infantry, 37th Division perimeter. The cleared area in front of perimeter greatly facilitated the use of tanks.

counterattacks which regained control of the high ground. The Japanese losses were large, 310 dead were counted within our wire compared to our losses of 16 killed and 42 wounded. The artillery placed an extremely heavy concentration in front of our lines following which only sporadic attempts to penetrate our wire occurred.

(3) Casualties:

U.S.Forces engaged		1850
Killed in Action	64	
Wounded in Action (died later)	14	
	78	4.2%

Dead		78	4.2%
Wounded in Action (duty)	160		
Wounded in Action (hospital)	212	372	20.1%
Total Casualties		450	24.3%

Japanese Forces engaged on 129th Sector up to 16-17 March when 600 more were added: 4300

Killed in Action (Counted)	2373
Ratio U.S. to Japanese dead	1:30



Fig.31: General Sherman Medium Tank and Infantrymen attack Japanese positions along the perimeter of 129th Infantry, 37th Division.

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Fig.32: Japanese killed on the perimeter of Co F, 129th Infantry, 37th Division. The enemy dead were hit by so many missiles it was impossible to determine cause of death.



Fig.33: Mass burial for Japanese killed on the perimeter of Co F, 129th Infantry. Heat and flies made early burial imperative.

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Fig.34: Hunting out any remaining Japanese that may have survived U.S.artillery fire concentrated on this area.



Fig.35: Japanese foxholes under bank of draw in 129th Infantry Sector. Note how jungle is cleared by artillery fire.

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Fig.36: An area devastated by artillery shell fire during advance on Japanese pillboxes near Torokino River.

d. Comment on Relative Large Number of Japanese Casualties

(1) Since one of the purposes of this study was to make observations on the relative lethal effects of weapons, the great disproportion between enemy casualties and our own deserves some comment. It is estimated that the enemy had 8,527 killed in action out of 10,000 troops involved in combat, as contrasted to 210 killed in action out of 5,800 U.S. troops involved. This is a ratio of 24.6 Japanese for each one of our forces killed.

(2) The approximate time for the Japanese attack was known as well as the most likely points of attack. Consequently the enemy attacked against extremely well prepared positions. Our supplies of ammunition were abundant and easily accessible to the front by an excellent system of roads. Our concentration of fire especially artillery and mortar was intensive. Our artillery concentration on Japanese reinforcements moving over restricted jungle tracks was particularly effective. We had complete control of the air making observation easy as well as bombing of enemy troop concentrations. The limited supply of enemy artillery and ammunition had to be transported by them under great difficulties over the most rugged terrain. Furthermore, as in other campaigns in the South Pacific, their artillery was never used in concentration as judged by our standards. Whenever the Japanese broke through our lines, which they did repeatedly, they never appeared to have reserves sufficient to follow up the advantage. There is evidence that the

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concentration of our artillery fire on their reinforcements prevented the accumulation of any effective body of troops.

(3) On Hill 260 the ratio of Japanese dead to U.S. was 8 to 1. This was the most favorable ratio for the Japanese in any of the three sectors. The enemy had taken the hill very early and acquired the advantage of the terrain. Consequently the action of our troops was mostly offensive under the disadvantage of retaking a hill in which the enemy occupied well dug in positions. The terrain prevented the use of tanks and the proximity of the lines limited the use of our artillery.

(4) On Hill 700 the ratio of Japanese dead was 36.3 to 1. While it was necessary here also to retake the crest of the hill, nevertheless the major part of our action was defensive in well prepared positions. The enemy approach to this sector was limited because of the terrain making artillery concentrations on their reinforcements highly effective and accounting for the greater number of enemy dead. On reaching the vicinity of our lines the enemy attacked up steep slopes in great concentration (see Fig.20)

(5) On the 129th Sector the ratio of Japanese dead to U.S.dead was 30 to 1. Here the approach for the enemy via the Numa Numa trail was easier and the terrain permitted attack on a wider front. However, the terrain was also favorable to the use of tanks; these were highly effective in retaking positions lost after the enemy had exhausted the force of their initial impact and their reserves had been disrupted by our artillery. On this sector also the enemy attacked in great concentration on a narrow front against strongly prepared positions. Our use of ball Canister was also highly effective against these concentrated attacks.

Control of the air, the use of tanks, and superior fire power in defensive positions, in addition to the greater and more effective concentrations of artillery fire, were the chief factors accounting for the large number of the enemy dead.

(6) Summary

Battle of the Perimeter

	Japanese	Allied
Total Forces Involved	24,000	60,583
Total Forces Under Fire	20,000	60,583[A]
Total Combat Troops	15,000	40,404[B]
Total in three Major Battles (estimated)	10,000	5,800[C]
Total Killed in 3 Major Battles (estimated)	8,527	210
Ratio dead 3 Major Battles	24.6	1

A All Allied forces within the perimeter were under enemy artillery fire.
B Total Allied Ground Forces.
C Does not include artillery and air force.

5. A STUDY OF BATTLE CASUALTIES

a. Total Battle Casualties and Disposition.

The term "battle casualty" in this report is used to designate those combatants who were killed or wounded by weapons only. All deaths or injuries produced by other agencies, such as falling trees, motor vehicle accidents etc., have been excluded. The total number of casualties includes all those wounded both by our own and enemy weapons. Wounds caused by Japanese weapons and those resulting from U.S. weapons have been separated, and are discussed under separate sections. It was impossible to ascertain which of the self-inflicted wounds were due to the soldiers wilful misconduct, and which were accidental. These wounds are included and discussed in the section on U.S.weapons. It is known that 12.1 per cent of the total casualties were produced by our weapons; however, the actual percentage may be slightly greater, for it is known that the enemy did use some of our captured weapons, particularly rifles and grenades.

There were 2,335 battle casualties. Of these 547 (23.4 per cent) were lightly wounded and were returned to duty immediately from the battalion aid posts, or collecting stations. These 575 casualties are included in the initial total for the sake of completeness, for it is assumed that reports of clinical studies in other armies are based on computations which also include this group of minor wounds. However, in the remainder of the study these patients have been excluded, because of the insignificant disability entailed by their injuries. Therefore, this study is based actually on 1,788 casualties who were killed in action, or who sustained wounds which necessitated hospital* treatment.

Since no exact definition for the term "killed in action" has been established, an arbitary standard was selected. In this study "killed in action" includes only those killed instantly, those found dead, and those who were mortally wounded and died shortly thereafter. Reports from division surgeons invariably contained a greater number of "killed in action" than are found in this study. An explanation for this discrepancy is apparent, and lies in the fact that the battalion surgeon ofttimes included among these, patients who were seen alive, but who were known to him to have died later. In this particular campaign, because of the close proximity of hospitals to the front, a large number of casualties are included under "wounded in action", who perforce under less favorable circumstances, would have been classified as "killed in action".

The "first echelon" refers to the islands of Bougainville, and "rear echelon" to the islands of Guadalcanal, [illegible], New Caledonia, Fiji Islands,

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* the term "hospital" includes two augmented clearing stations. The majority of patients returned to duty in the first echelon were treated in these clearing stations.

and New Zealand. With few exceptions all patients who were returned to duty in the first echelon left the hospital within thirty days. Patients in a hospital of the rear echelon who were not evacuated to the United States were usually returned to duty within 120 days.

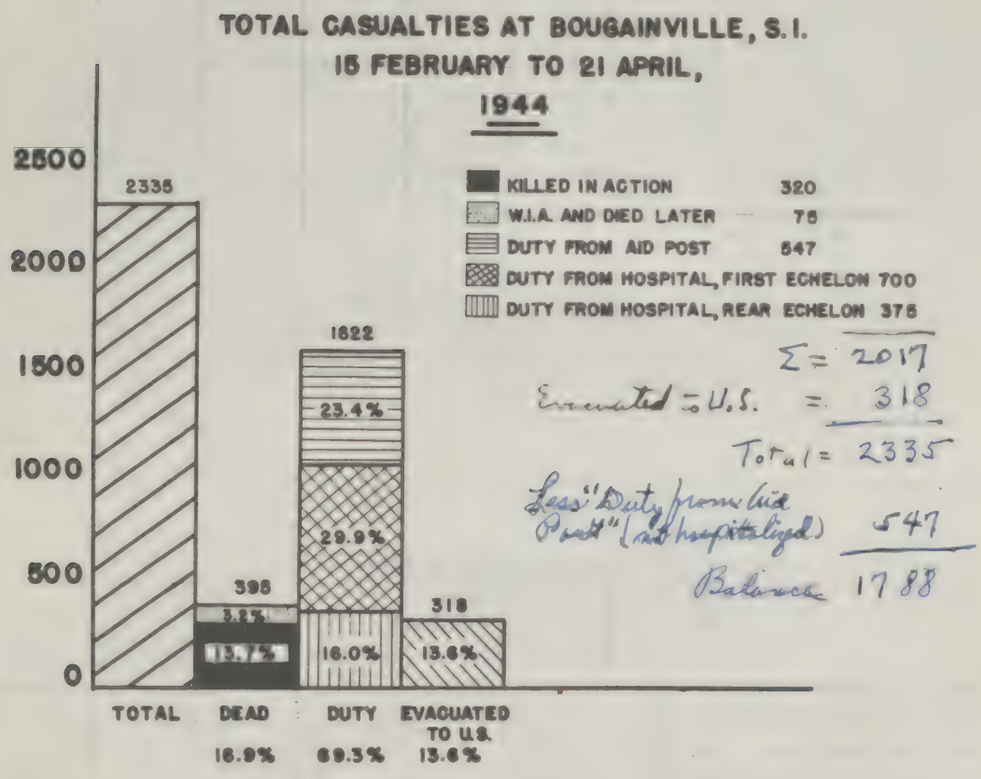


Fig. 37

The total number of our casualties on ~~Bougainville~~ are shown in Fig. ~~37.~~ It may be seen that the dead (395) constitute 16.9 per cent of the total casualties (2,335). Thus, approximately one out of every six wounded were killed. Nearly seventy per cent of all casualties were returned to duty and of the living wounded (1940), 1,622 or 83.6 per cent were returned to duty. However, 547 of these were returned to duty from a first aid post and did not require hospitalization. These soldiers had very minor wounds and were not lost to battle. Since the incapacitating effect of weapons on this group was negligible, they were eliminated from the remainder of this study, leaving 1,788 casualties who were killed or whose wounds were of such severe degree that they were lost to the battle. Using this criterion one out of every four and a half men wounded were killed. Those who died and those who were evacuated to the United States were classed as "lost to service" ~~in the South Pacific Theater~~ and

comprised 30.5 per cent of the total casualties.

b. Wounds by Region and Disposition of the Wounded

The remainder of this study is based on 1,788 battle casualties who were admitted to hospitals or killed in action. The disposition of patients according to the region wounded is shown in Fig. 32. All casualties were classified under anatomical regions according to the location of the wound. In many instances a major wound was accompanied by one or more minor wounds. In this event the anatomical location of the major wound alone determined the classification. Furthermore, if a single wound among others was responsible for death or disability, the anatomical location of that wound determined the classification. Only under the circumstance that two or more wounds in one individual may have resulted in death or disability, was the classification "Multiple Wounds" utilized. Because of the difficulty in analysis of the "Multiple Wounded" every effort was made to keep to a minimum the number so classified. Nevertheless, the "Multiple Wounded" constituted 18.6 per cent of the casualties.

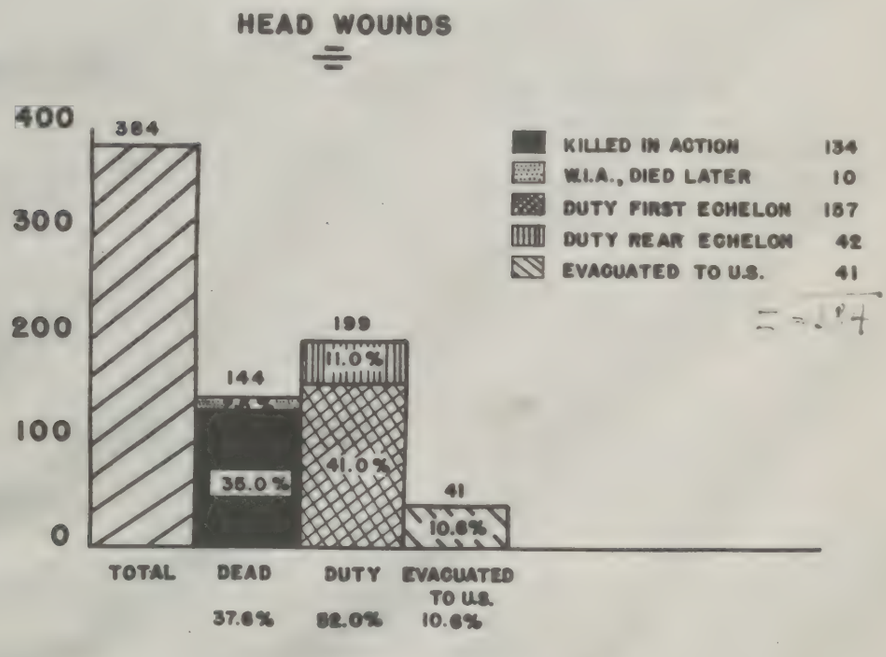


Fig. 38

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(1) Head Wounds.

Head wounds alone constituted 21.4 per cent of all battle casualties. Of the 134 soldiers in this group killed in action, death resulted from brain injury in 125 and from wounds of the face and neck in nine. In the ten patients who were wounded in action and died later, nine sustained brain injuries, and one a transection of the cervical spinal cord. A more detailed description of these ten patients will be found under "Treatment of the Wounded" (Section 6). Two hundred and forty patients survived, and of this number more than half (64.4 per cent) were returned to duty in the first echelon. The disposition of the living according to wound is shown below.

	Brain	Face and Neck	Eye	Scalp	Concussion
Duty First Echelon	0	71	10	50	26
Duty Rear Echelon	4	18	8	11	1
Evacuated to U.S.	12	15	12	2	0

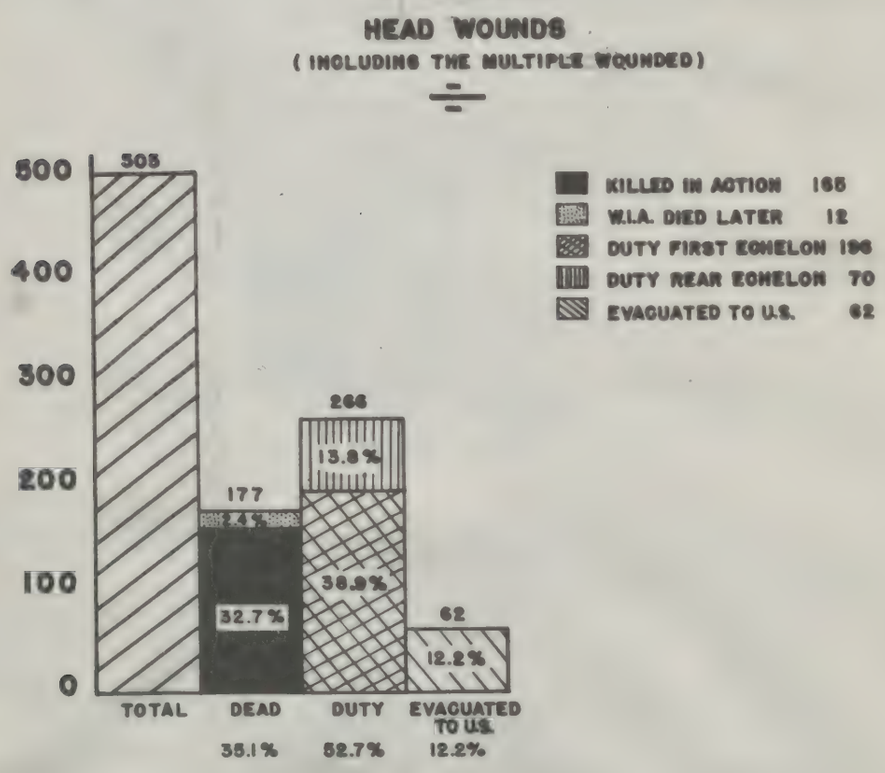


Fig. 39.

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In Fig. 39 the head wounds previously summarized (in Fig. 38) are combined with those head wounds which are described later under "Multiple Wounds", making a total of 505. It is evident by comparison of the two charts that the ratio of the dead to those evacuated to the United States, and to those returned to duty, remains relatively unchanged. (The inclusion of multiple wounds with those classified under single anatomical regions may lead to duplication and confusion. For this reason multiple wounds have not been included in any charts except those devoted to the analysis of head wounds).

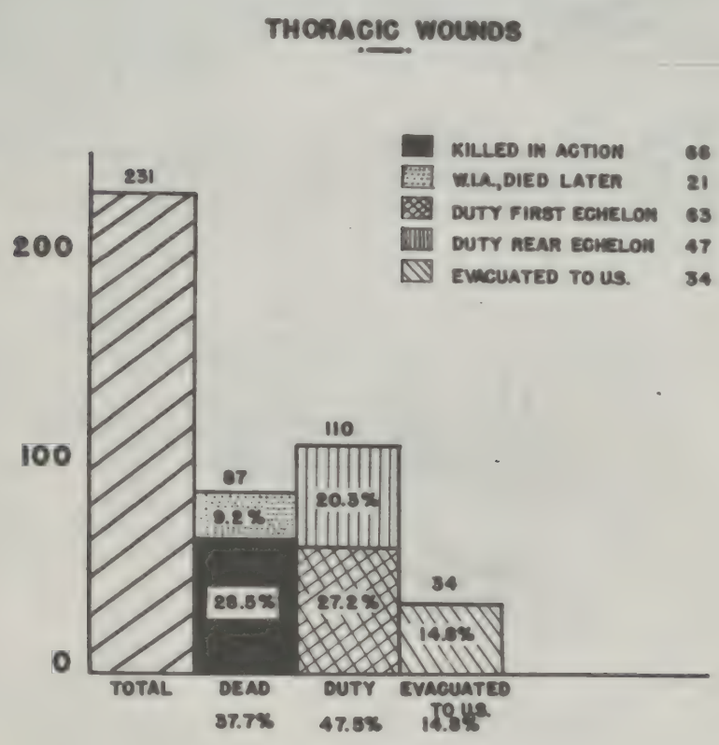


Fig. 40 4

(2) Wounds of Thorax.

Thoracic wounds accounted for 12.9 per cent. of all battle casualties. Sixty-six of the dead were killed in action. Of the twenty one who were wounded in action and died later, fifteen died during or following operation. Perforating wounds of the thorax were present in all those who were killed or died later. Sixty three patients were returned to duty in the first echelon. Of these only three had wounds which penetrated the pleural cavity. All others had wounds of the chest wall only.

In the group of forty seven patients returned to duty from the rear echelon, thirty three sustained chest wall wounds only. Among the remaining fourteen with lesions involving the lung or pleura, six underwent lung operation. Thirty four patients were evacuated to the United States. Twenty four of these had injuries of the lung, nineteen of this group were treated by surgical operation, and five by conservative measures. The remaining ten patients had wounds of the chest wall which did not communicate with the pleural cavity.

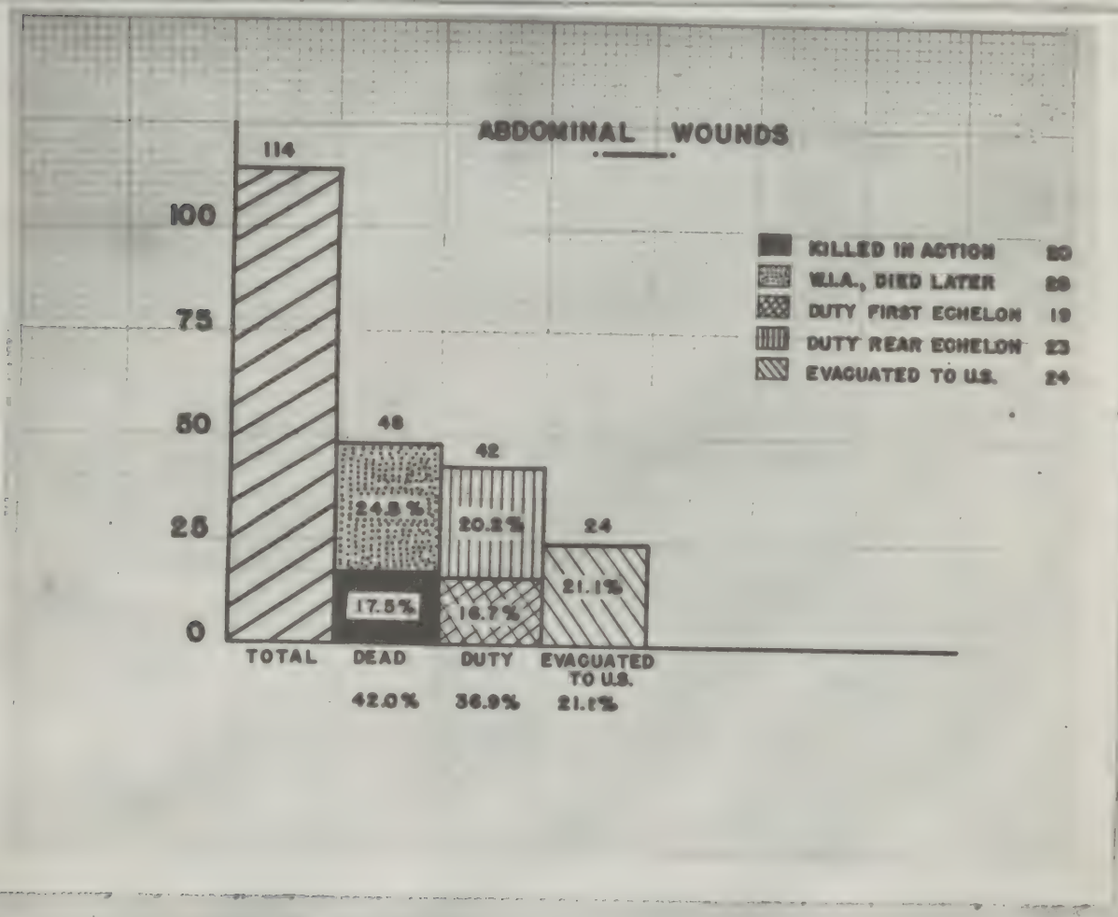


Fig.41

(3) Wounds of Abdomen

One hundred and fourteen patients sustained abdominal wounds. The abdomen was struck less frequently than any other anatomical region and these wounded constituted the smallest number (6.[illegible] per cent) of all casualties. In ten patients, wounds involving both the abdomen and thorax with perforation of the diaphragm were present. (See Section 6 c for a more detailed description of thoraco-abdominal wounds). Twenty patients were killed in action, one of whom sustained a transection of the spinal

cord. A relatively greater number (24.5 per cent) of patients were wounded in action and died later in this group than any other. Of these twenty eight patients only three died without operation. In most instances death resulted either from shock and hemorrhage or from peritonitis. The entire group of nineteen patients returned to duty in the first echelon had wounds of the abdominal wall only. Twenty three patients were returned to duty from the rear echelon, thirteen of whom had abdominal wall wounds, one a combined thoracico-abdominal wound, and the remainder visceral lesions distributed as follows: liver four, colon two, spleen, kidney, and bladder one each. ~~Fewer patients wounded in the abdomen (30.9 per cent) were able to return to duty, than were those wounded in any other region.~~ Nineteen of the twenty four patients evacuated to the United States had injuries of the abdominal viscera, five had abdominal wall wounds and one a transection of the cauda equina. The visceral lesions among these patients were distributed as follows: small intestine six, small intestine and colon four, colon three, spleen and diaphragm two, stomach and liver, colon and diaphragm, and bladder one each.

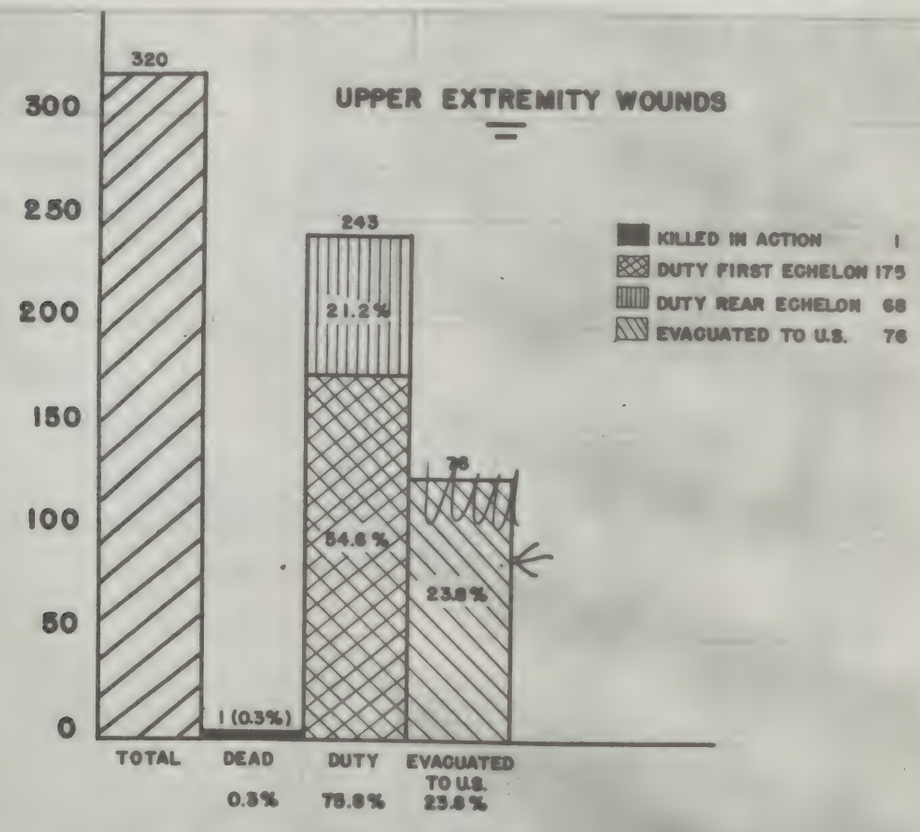


Fig. 12

(4) Wounds of the Upper Extremities

Wounds of the upper extremity alone constituted 17.9 per cent of all battle casualties, yet wounds of

this region carry a death risk of only 0.3 per cent. No patients died who received treatment. The number of patients returned to duty in the first echelon is greater among those receiving upper extremity wounds than among those wounded in any other region. Of these 175 patients, four had fractures of the hand, and two incomplete fractures of the arm. In the sixty eight patients returned to duty from the rear echelon there were twelve fractures as follows: six of the bones of the hand, and two each of the scapula, humerus, and forearm. Fifty eight compound fractures and five amputations were found in the sixty six patients evacuated to the United States. These fractures were distributed as follows: humerus twenty three, bones of the forearm nineteen, bones of the hand twelve, and scapula four. The percentage of patients evacuated to the United States was higher in upper extremity wounds than in wounds of any other anatomical region.

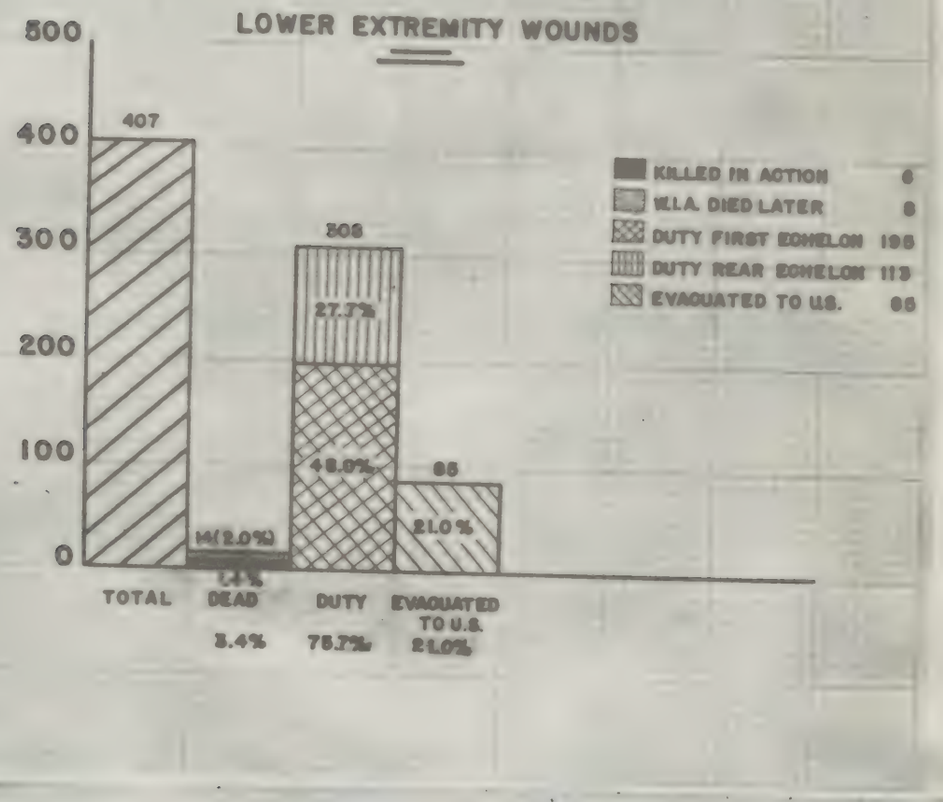
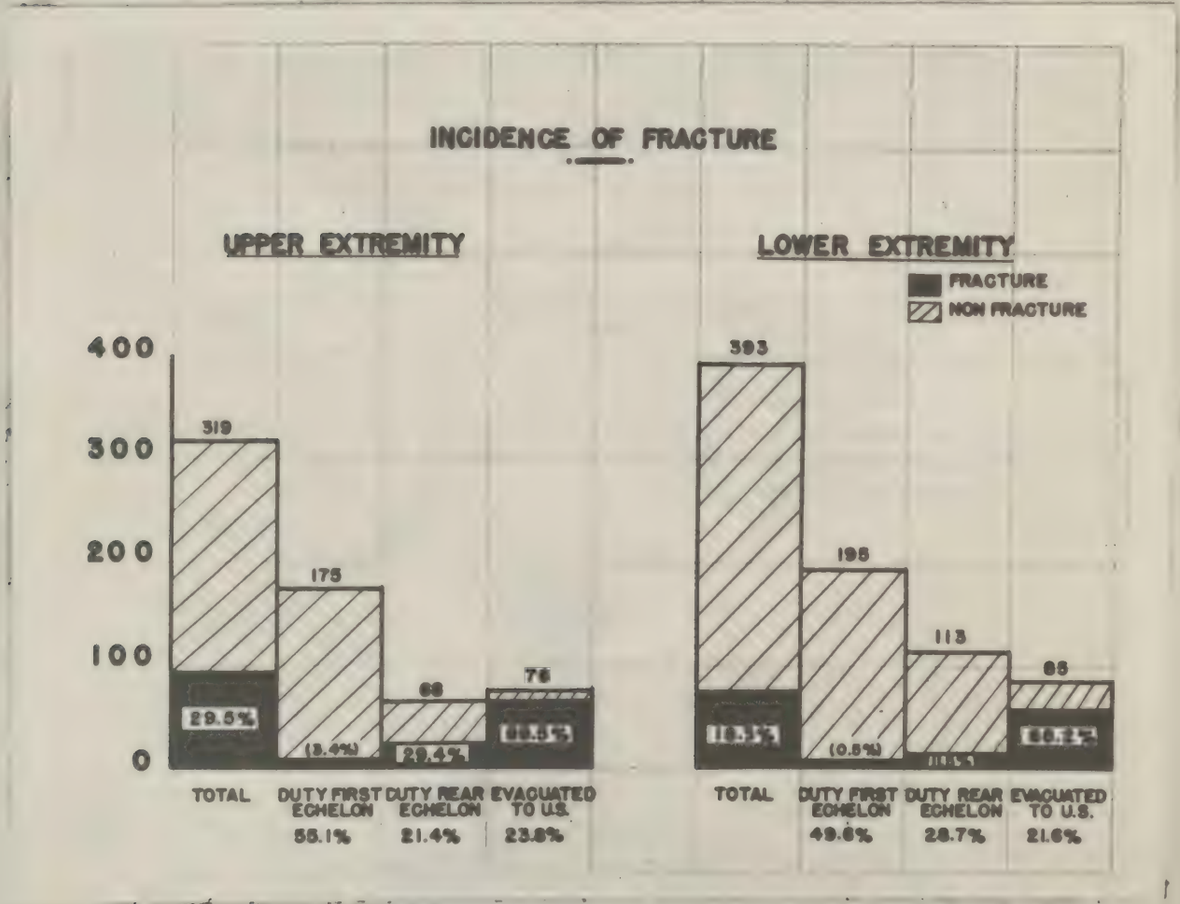


Fig. 62

(5) Wounds of the Lower Extremities.

Wounds of the lower extremity were the most numerous of all battle wounds, (22.7 per cent)

~~for next to the lowest mortality of any region (1.4 per cent).~~ 3.4 erroneous
There were six casualties classed as killed in action although with one exception all were alive when first seen. These soldiers either could not be reached or else died before adequate medical aid could be given. (See case histories in Section 6 e.). There were eight patients who were wounded in action and died later. Seven of these died in the first echelon and one in the second echelon. Of the seven deaths in the first echelon, two resulted from gas gangrene, and five from shock and hemorrhage. Two deaths in the latter group might have been avoided by the use of a tourniquet. One hundred and ninety five patients were returned to duty from the first echelon. With the exception of one patient who had a chip fracture of the tibia, all of these patients had soft tissue wounds only. From the rear echelon one hundred and thirteen patients were returned to duty, eight of whom had fractures of the bones of the leg and four of the bones of the foot. Eighty five patients were evacuated to the United States. In this group fifty nine compound fractures were present and distributed as follows: bones of the leg thirty one, femur eighteen, and bones of the foot nine. In addition there were ten amputations of the thigh or leg.

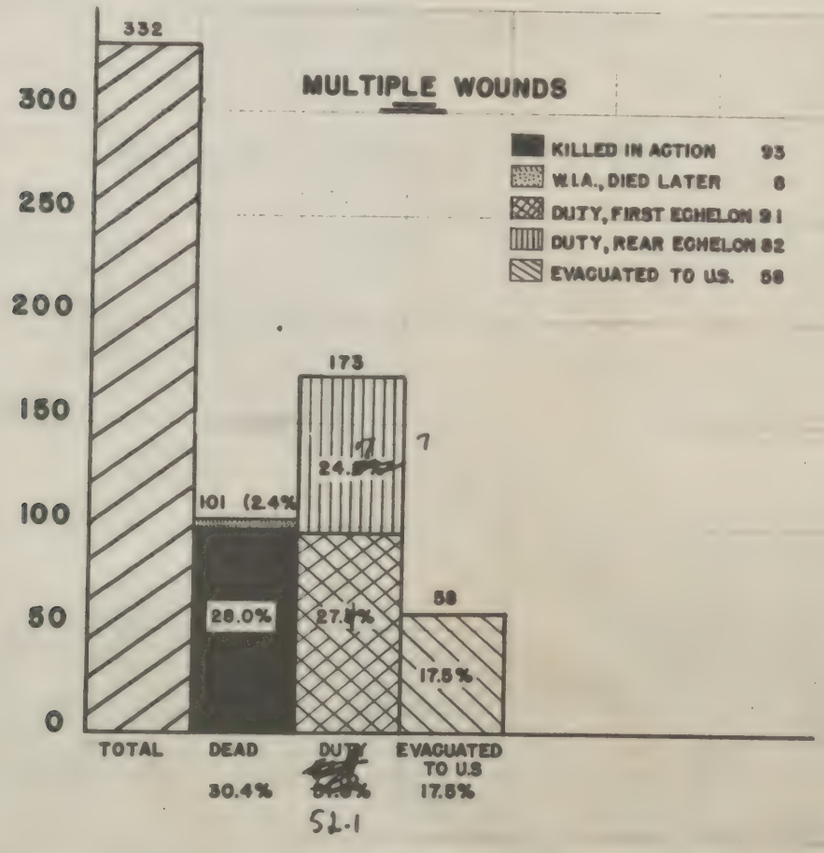


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(6) Incidence of Fractures.

The risk of death in wounds of the extremities is low. In 727 wounds of the upper and lower extremities there were fifteen deaths (2.0 per cent). On the other hand, wounds of the extremities constituted half of all patients evacuated to the United States. The majority of patients with wounds of the extremities who were lost to the service by evacuation had fractures as shown in Fig. 7. Fractures among upper extremity wounds are more common (29.5 per cent) than among the lower extremity lesions (18.3 per cent). The greater relative volume of soft tissue to bone in the lower extremity may explain the lower incidence of fracture. On the other hand the explanation may lie in the fact that the percentage of high velocity missile wounds are slightly greater in the upper than in the lower extremity. Bullets produced 36.9 per cent of all wounds of the upper extremity and 27.9 per cent of the wounds of the lower extremity. Patients who returned to duty in the first and second echelons usually had fractures of small bones, chip and perforating fractures and other fractures with minimal bone damage. It should be noted in Fig. 44 that 89.5 per cent of the patients with wounds of the upper extremity and 68.2 per cent of those with wounds of the lower extremity were evacuated to the United States because of fractures. The cause of fractures is discussed further in a later section devoted to the relative effect of weapons.



51-1

(7) Multiple Wounds

Wounds were classed as "multiple" only if two or more wounds of different regions could have caused death or disability. Such wounds caused 18.6 per cent of all battle casualties. As in wounds of the head when death occurred, it was usually instantaneous. On the other hand a relatively high percentage of patients with multiple wounds were returned to duty. Ninety one patients were returned to duty from the first echelon in which group there were two hundred and three soft tissue wounds distributed as follows: upper extremity seventy three, lower extremity sixty one, thoracic wall twenty two, face and neck twenty, scalp fourteen, abdominal wall eight, and eye five. Present also were chip fractures of the clavicle, finger and leg. From the rear echelon eighty two patients were returned to duty with one hundred and eighty six soft tissue wounds distributed as follows: upper extremity sixty two, lower extremity sixty one, thoracic wall twenty four, face and neck seventeen, scalp ten, abdominal wall eight, abdominal perforations two, (spleen and rectum), eye one and lung perforation one. There were eight chip fractures, six of the upper and two of the lower extremity, and also two perforating fractures of the pelvis. In addition there were two finger amputations. Fifty eight patients having a total of one hundred and fifty three soft tissue wounds and fractures were evacuated to the United States. The thirty eight fractures were distributed as follows: upper extremity twenty, lower extremity sixteen and jaw two. The following soft tissue wounds were present; upper extremity thirty six, lower extremity thirty four, thoracic wall sixteen, face and neck twelve, eye five, amputations five, scalp three, brain one, and abdominal wall one. Among these patients with multiple wounds, fractures were the chief cause for evacuation to the United States.

c. The Anatomical Distribution of Wounds

A study of both the living and the dead is essential in order to gain an accurate and complete picture of the anatomical distribution of wounds produced by various weapons. Although many wound studies have been made on the living, few records are available which analyze the effect of weapons on both the dead and living. In this investigation data concerning all those who were killed in action as well as those who were wounded in action and died later have been collected and combined with the records of the living wounded.

Information regarding the circumstances of wounding in the living is relatively easy to obtain, frequently the facts may be elicited by an interview with the person wounded. However the information will be still more accurate if checked with an eye witness. To secure accurate details concerning the dead, however, is much more difficult. Post mortem examinations should be done of course when ever possible. Autopsies, however, were limited by the fact that all bodies could not be recovered, and also by the fact that some were decomposed when recovered. Unfortunately rapid deterioration

occurs in the tropical climate of Bougainville, and for sanitary reasons the dead must be buried as soon as possible. The dead, when recovered, frequently exhibit wounds other than those which produced death. Wounds inflicted after death were especially common in areas subjected to concentrated artillery or mortar fire. Furthermore, it was often difficult and frequently impossible to identify the lethal weapon from the appearance of the wound or missiles recovered at autopsy. In many instances discrepancies were found, when the emergency medical tag, hospital record and post-mortem findings were compared. It became apparent, therefore, that the true sequence of events leading to death could be secured only by careful personal questioning of witnesses who saw the soldier killed, or who knew personally of the circumstances surrounding his death. By adhering to this method of investigation, a relatively high degree of accuracy was achieved, not only in the records of the dead but also of the living.

In the classification of the wounded, it became necessary to add to the conventional division by anatomical regions, an additional group which was designated "Multiple Wounds". The term "multiple wounds" is used for those casualties sustaining two or more wounds, either one of which might have been responsible for the soldiers death, or for rendering him unfit for action. It was difficult or impossible to classify accurately all casualties who received more than one wound. In many instances the dead were struck by other missiles after death, under which circumstances it was not possible to decide which of several wounds produced death. In other instances decomposition of the body made examination unsatisfactory. For these and other reasons some patients were placed in the "multiple wound" classification, who probably should have been included properly with those grouped under single anatomical regions.

It is desirable in a study of this kind if possible to evaluate the influence of various factors on the anatomical distribution of wounds. Particular consideration should be given to the type of action, whether defensive or offensive, available cover or protection, armor, terrain and type of weapon and projectile employed. Furthermore, if a true representation of the distribution of wounds is to be established, the data should be derived from a study of the dead as well as the living.

Table I

In ~~Fig.46~~ the anatomical distribution of wounds in the living and dead in Bougainville is compared with similar wound distributions in the living in past and present wars. It will be observed that head wounds were more frequent at Bougainville than elsewhere. Perhaps this was due to the relatively close range of rifle fire in jungle warfare. Another discrepancy is observed by comparing the percentage of wounds of the head, chest and upper extremities in the living. For example, wounds of these regions on Bougainville attained a total of 60.5 per cent, whereas the Russians in World War II report only ~~40.5~~ 49.5 per cent.

DISTRIBUTION OF WOUNDS

REGION	LIVING						DEAD
	American Civil War	World War I		World War II		Bougainville	Bougainville
		U.S.	Britain	U.S.	Russia		
Head, Face, Neck	9.1	11.4	16.8	16.1	9.1	20.7	49.0
Upper Extremities	36.6	36.2	30.4	28.2	28.0	27.4	0.3
Chest	11.7	3.6	7.8	9.8	11.4	12.4	29.6
Abdomen	6.0	3.4	4.7	5.6	6.2	5.7	16.3
Lower Extremities	36.6	45.4	40.3	40.3	45.3	33.8	4.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Fig. 46.

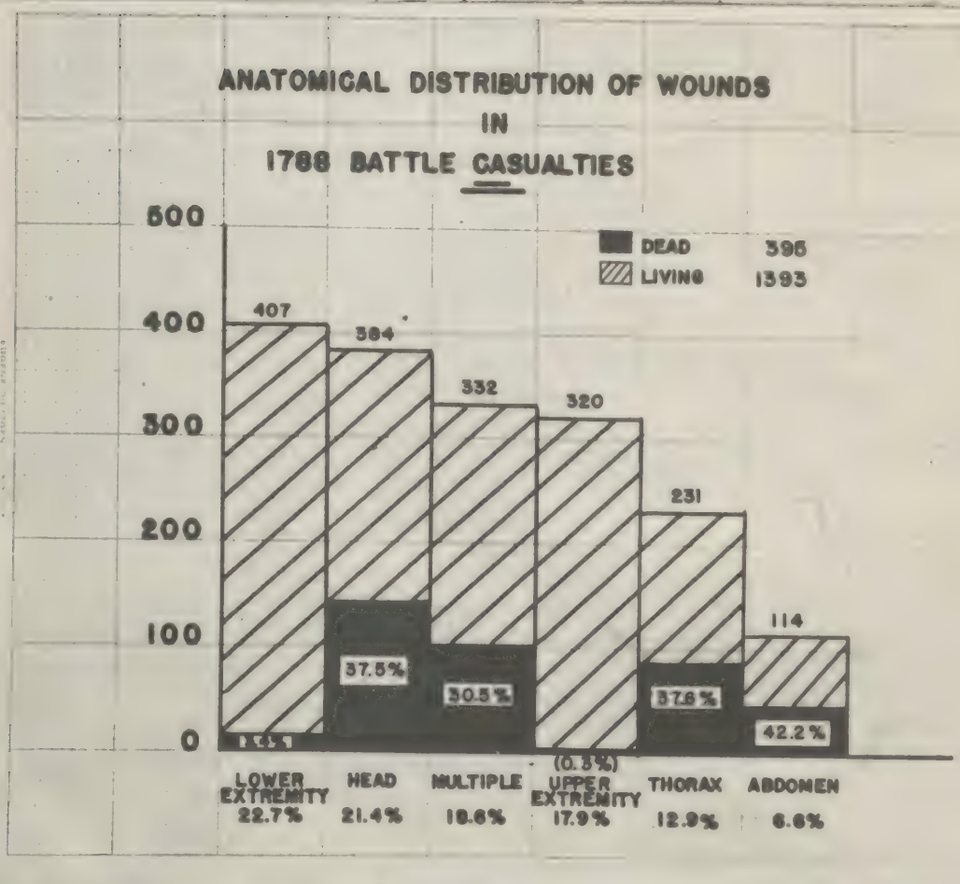


Fig. 47.

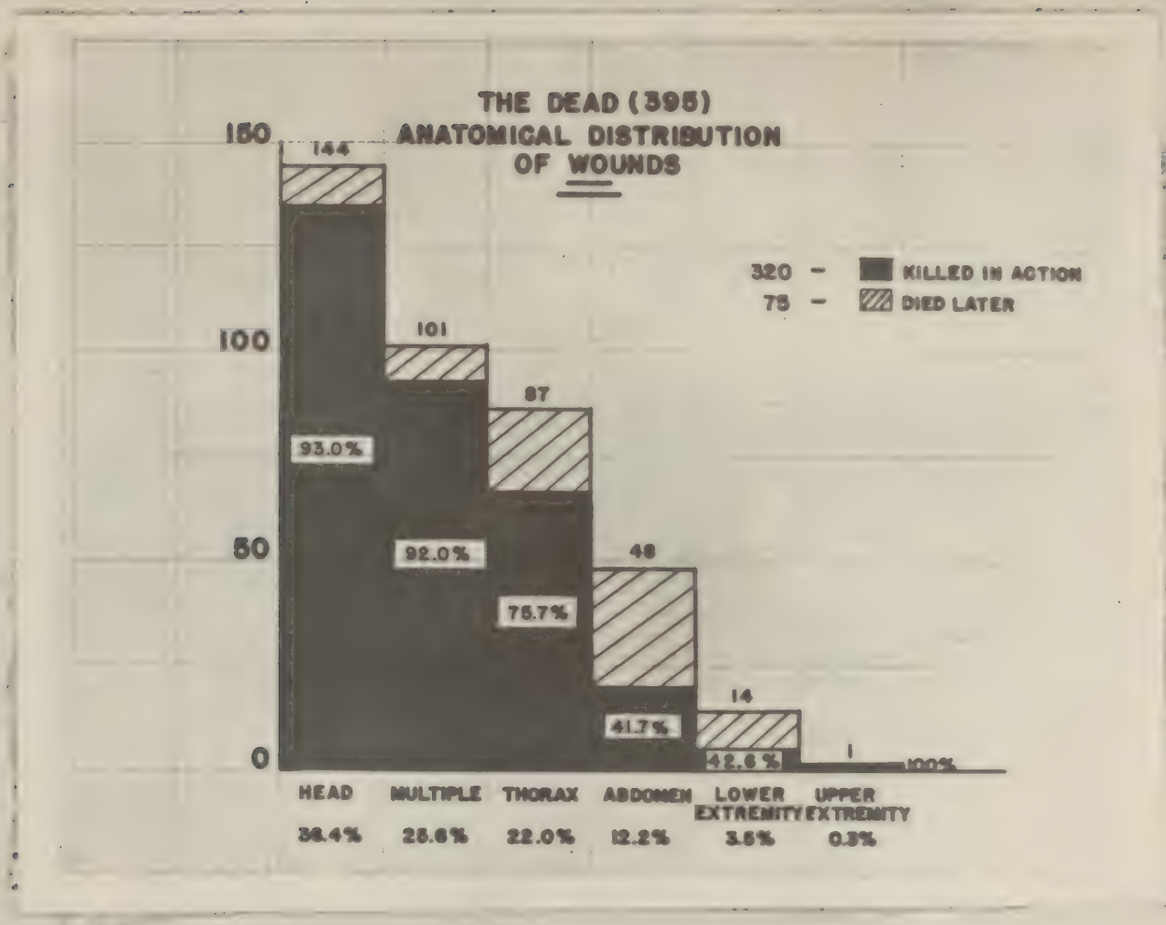


Fig. 48. 10

With the exception of head wounds the anatomical distribution of wounds in jungle warfare does not appear to differ greatly from the distribution of wounds reported for other types of warfare. In the absence of available data on other types of warfare it is difficult to derive an adequate explanation for this high frequency of head wounds. The mortar followed closely by the rifle was the most frequent cause of wounds of the head. Since rifles are used frequently, and at close range, in jungle warfare, it is suggested that the greater number and accuracy of bullets might account for the high incidence of head wounds. However, we can offer no proof of this hypothesis. The factor of exposure appears to offer no better explanation, since the head is apparently exposed to the same degree in the jungle, as in other types of warfare. The predominance of lower extremity and multiple wounds is accounted for by the high incidence of mortar hits.

10 The anatomical distribution of wounds in the dead (Fig. 48) is in striking contrast to the distribution of wounds in the living. The low incidence of extremity wounds among the dead is a rough index of the effectiveness of modern surgery, when dealing with wounds which do not involve a vital organ. Multiple wounds hold second place among the dead. Bullets, mostly at close range, caused 36.4 per cent

of all deaths, while high explosives caused 38.4 per cent. A consideration of those who were wounded in action and died later (Fig.48) indicates that the major problem is encountered in wounds of the abdomen and thorax. These two regions accounted for 65.3 per cent of all those who were wounded in action and died later.

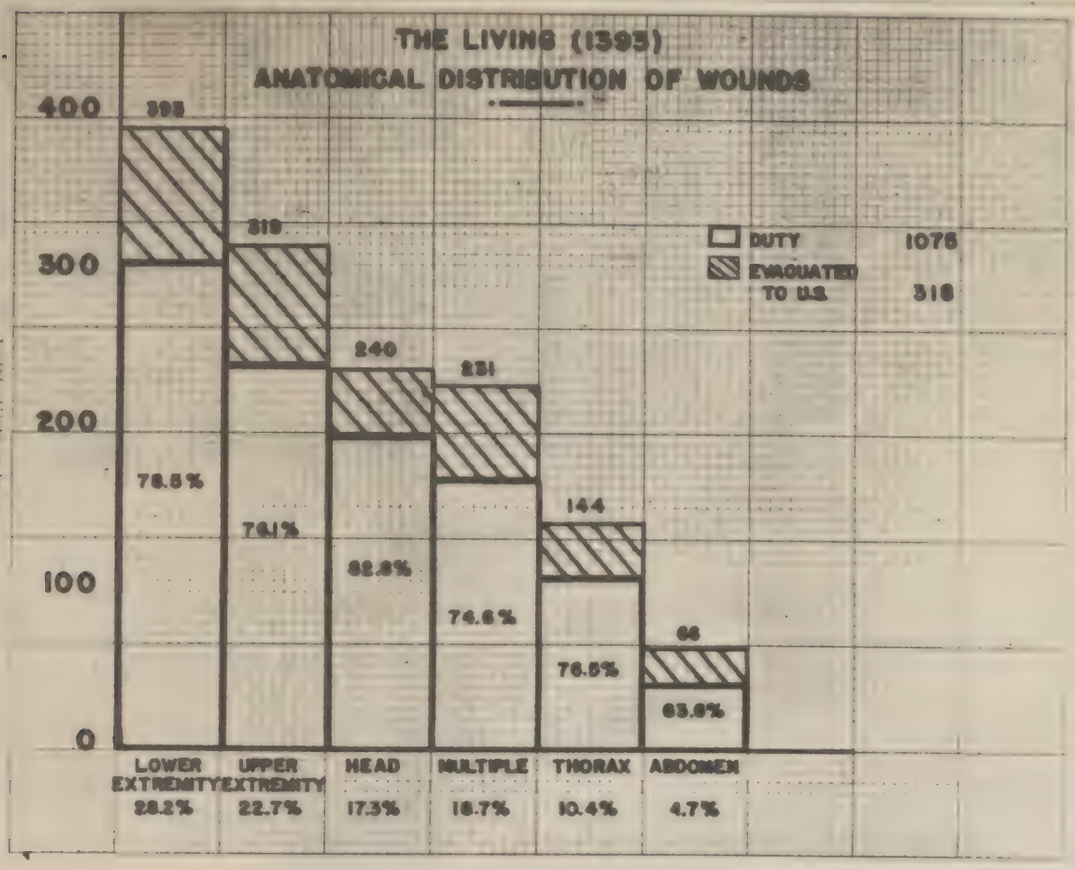


Fig.49.

An index of the degree of the residual disability may be obtained by a consideration of the number of patients returned to duty or returned to the United States (Fig.~~49~~.) It should be noted that while the total number of patients in the anatomical divisions varies considerably, the percentage of patients returned to duty in each anatomical region remains remarkably constant.

The anatomical distribution of wounds may vary according to the type of weapon causing the wound, the degree of exposure of different parts of the body, the protection afforded by various means, and the direction of fire. If the body were unprotected in an atmosphere of flying missiles of equal distribution, wounding should occur in direct proportion to the exposed surface area. However, such a theoretical condition never exists. On the contrary missiles

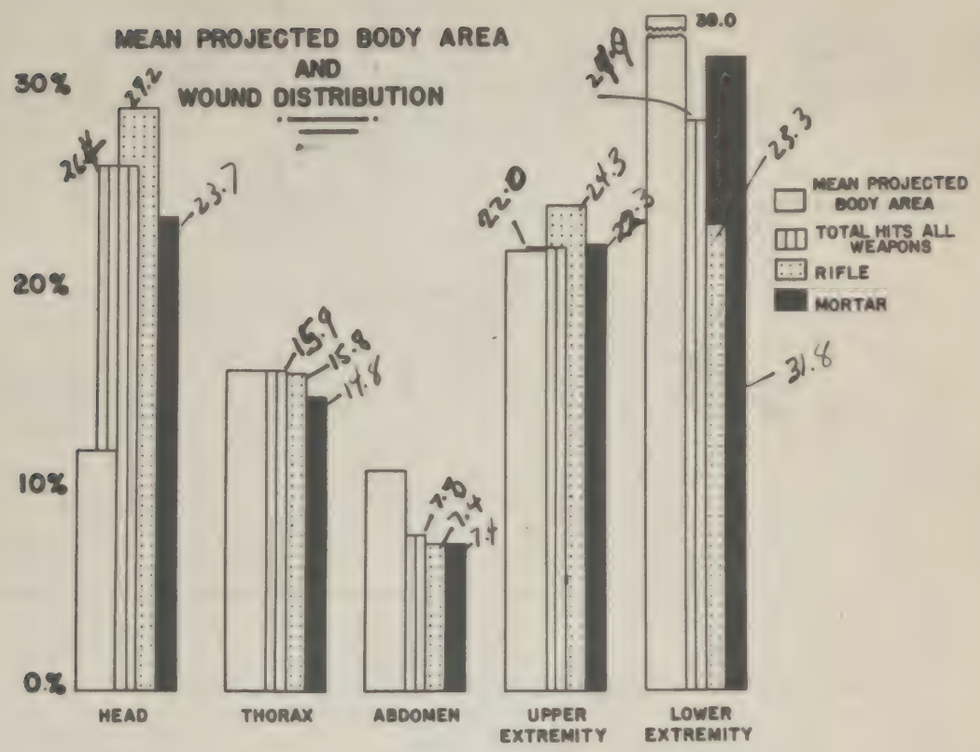


Fig. 50 IV

usually move in one direction at a given time. The projected area of the body if completely exposed, therefore, offers a better measure for the study of the probable hits. The mean projected body area is obtained from projections in three positions, standing, sitting and kneeling.* The hits with all weapons are compared with the mean projected body area (Fig. 50) IV The head is the only region in which the percentage of wounds appreciably exceeded the percentage of the projected area for that region. The percentage of hits in the abdominal area is considerably less than the percentage of its projected area. The question may be raised as to why wounds of the head so far exceed the projected head area. Was this due to good marksmanship or exposure? Obviously the head must be exposed for marksmanship to be effective. Since wounds caused by rifle bullets and mortar shell fragments were found in significant numbers and the circumstances were known with reasonable accuracy, they may be compared. The directed fire of the rifle and the undirected hits with mortar fragments were found to approximate closely the total hits by all weapons. This is evidence that exposure is one of the chief factors in accounting for the high incidence of head wounds. Nevertheless,

* (Mean Projected Body Area) from R.C.No.350 of the Research and Experiments Department of The Ministry of Home Security. "The wounding power of small bomb and shell fragments" by E. Delish Burns and S.Zuckerman, Abst. Bulletin of the Conference on Wound Ballistics, Page 5.

the number of wounds caused by rifle fire does exceed the number caused by mortar fragments in the head, upper extremity and thorax. This may be interpreted as evidence that marksmanship does play a small but important part in the high incidence of head wounds. This observation is further substantiated by the fact that the lower extremity presents the reverse of these findings.

d. The Different Weapons Causing Battle Casualties

It is obvious that the number of battle casualties produced by various weapons will depend upon the type of warfare, the number of weapons employed and the training and tactics of the opposing forces. Thus, the measure of effectiveness of a given weapon must vary necessarily according to the circumstances under which it is used. The effectiveness of a weapon depends not only upon the total number of casualties it produces, but also upon the ratio of the killed to wounded and upon the severity of the wound. In a certain local situation the most effective weapon might be one which temporarily disabled the greatest number of the enemy and hence allowed the capture of a particular objective or the winning of a single battle. If the effectiveness of a weapon is to be measured by this latter criterion, it would be necessary to set up an arbitrary definition of "temporary disability". In this event a solution of the problem would be found in classifying the wounded on the basis of "ability to continue combat if life depended upon it".

The ratio of the killed to wounded is subject to various interpretations and must be clarified. As previously stated the term "killed in action" in this study indicates those killed instantly and those who were mortally wounded and died within a relatively short time. Because of the proximity of medical installations at Bougainville, many mortally wounded patients lived to reach the hospital and were classified among those who were wounded in action and died later. Doubtless under other less propitious circumstances, many of these casualties would have been classified with those who were killed in action. The term "dead" refers to the total number of those killed in action and those who were wounded and died later.

Since the severity of a wound is an abstract quality, open to individual interpretation and judgement and hence to consequent error, it was necessary to establish another criterion by which to judge the degree of disability sustained. The ultimate disposition of the patient seemed to offer a more reasonable basis for this estimation and was selected. All wounded, therefore, were separated into three groups depending upon whether the nature of the wound allowed the patient to be returned to duty from the first or from the rear echelon, or whether it necessitated his return to the United States. It is recognized that this is an arbitrary standard and open to the criticism that it is also an index of medical care, nevertheless, it is a factual and objective measure of the relative effect of weapons in the living wounded. The following charts are designed to illustrate the relative effectiveness of various weapons, as judged by these different standards.

A fairly comprehensive description of the common types of enemy weapons used on Bougainville will be found under the section entitled "Japanese Weapons" (Section 4 d). From wound examination alone it was never possible to distinguish the caliber of rifle or machine gun bullets nor the size of explosive shells. It was frequently impossible to judge with any accuracy whether the wound had been produced by grenade, shell fragment, bomb, or bullet. Estimations based on captured weapons show that the ratio of the 6.5 mm (.256 inch) to the 7.7 mm (.303 inch) caliber rifle was approximately four to one. Similarly the 6.5 mm machine gun bore the same ratio (four to one) to the 7.7 mm model. If the "knee mortar" (grenade discharger) is included with all other captured mortars, it constitutes approximately 90 per cent of the total. The ratio of the 81 mm mortar to the 90 mm was about three to two. The most commonly used artillery weapons were the 37 mm and the 75 mm guns, and the 70 mm and 150 mm howitzers. Among these the 75 mm gun predominated. Aerial bombing by the enemy did not occur during the battle of the perimeter. Wounds by miscellaneous weapons were produced by the bomb (U.S.aerial bombs) thirteen, pistol thirteen, bangalore torpedo nine, powder explosion five, bayonet two, bazooka one and parachute flare one.

(1) The Relative Lethal Effect of Weapons

The phrase "relative lethal effect" of a weapon refers to the percentage of deaths among the total number of casualties (dead and wounded) caused by that particular weapon. As previously stated, the ratio of the number of deaths to the number of casualties produced by any given weapon depends upon such variable factors as the type of action (offensive or defensive), number of weapons employed, terrain exposure and available protection. These factors primarily determine the necessary degree of exposure of the soldier and consequently the number of hits, other factors being equal. The type and number of the particular weapon employed is then of prime importance in determining "the relative lethal effect". For example a small number of machine guns may produce few casualties but a "high lethal effect", whereas, a great many casualties may result from heavy mortar fire yet the "lethal effect" will remain relatively low.

A comparison of the incidence of casualties caused by different weapons (Fig. 51) shows that the mortar wounded more men (38.7 per cent) than any other weapon. This is the weapon most feared by our troops. However, the relative lethal effect of the mortar is low (11.8 per cent) rating next to the grenade which has the lowest (6.3 per cent) relative lethal effect. There were 1,741 casualties caused by high explosive shells, grenades, land mines and bullets (not including the small group of casualties produced by miscellaneous weapons). Excluding bullets; high explosive shells, grenades and mines caused wounds in 1,144 men (65.7 per cent), however, in this group only 153 deaths (39.7 per cent) occurred. In contrast bullets wounded 597 men (34.3 per cent), but they accounted for 231 deaths (60.3 per cent).

The rifle was responsible for wounds in 445 casualties with a lethal effect of 32.2 per cent. The machine gun, while causing fewer casualties (152), had the highest lethal effect of 58 per cent. The very low lethal effect of the grenade (6.3 per cent) is a characteristic probably peculiar to the Japanese hand grenade. Thirty three of the thirty four land mine casualties were produced by our own mines. The forty seven casualties listed under miscellaneous weapons were caused by pistols, bangalore torpedoes, bazookas, flares, powder explosions and bayonet wounds.

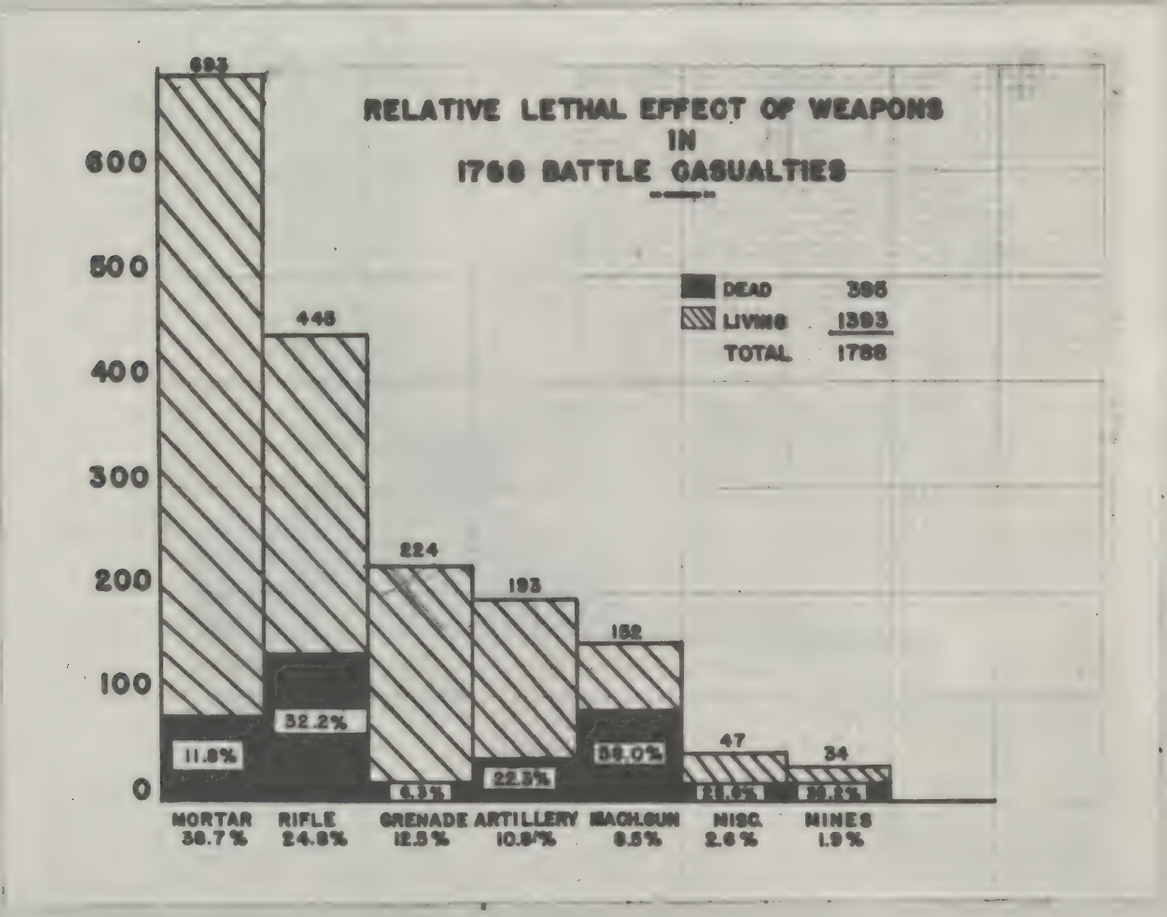


Fig. 31.

(a) Wounds of the Head

There were 384 casualties (21.4 per cent of the total number) due to wounds of the head alone. Moreover wounds of the head accounted for 36.4 per cent of all dead (144). Excluding the five wounded by miscellaneous weapons, 208 head casualties (55 per cent) were produced by high explosives and 171 (45 per cent) by bullets. However, high explosives accounted for only 27.1 per cent of the dead, whereas, bullets were responsible

for 72.9 per cent. Thus while high explosives caused more casualties, the lethal effect produced was relatively low. This may be explained by the average lower velocity of shell fragments and the relative greater protection afforded against them by the helmet and skull. This is further substantiated by the fact that in 92.3 per cent of the deaths due to head wounds, the skull had been penetrated.

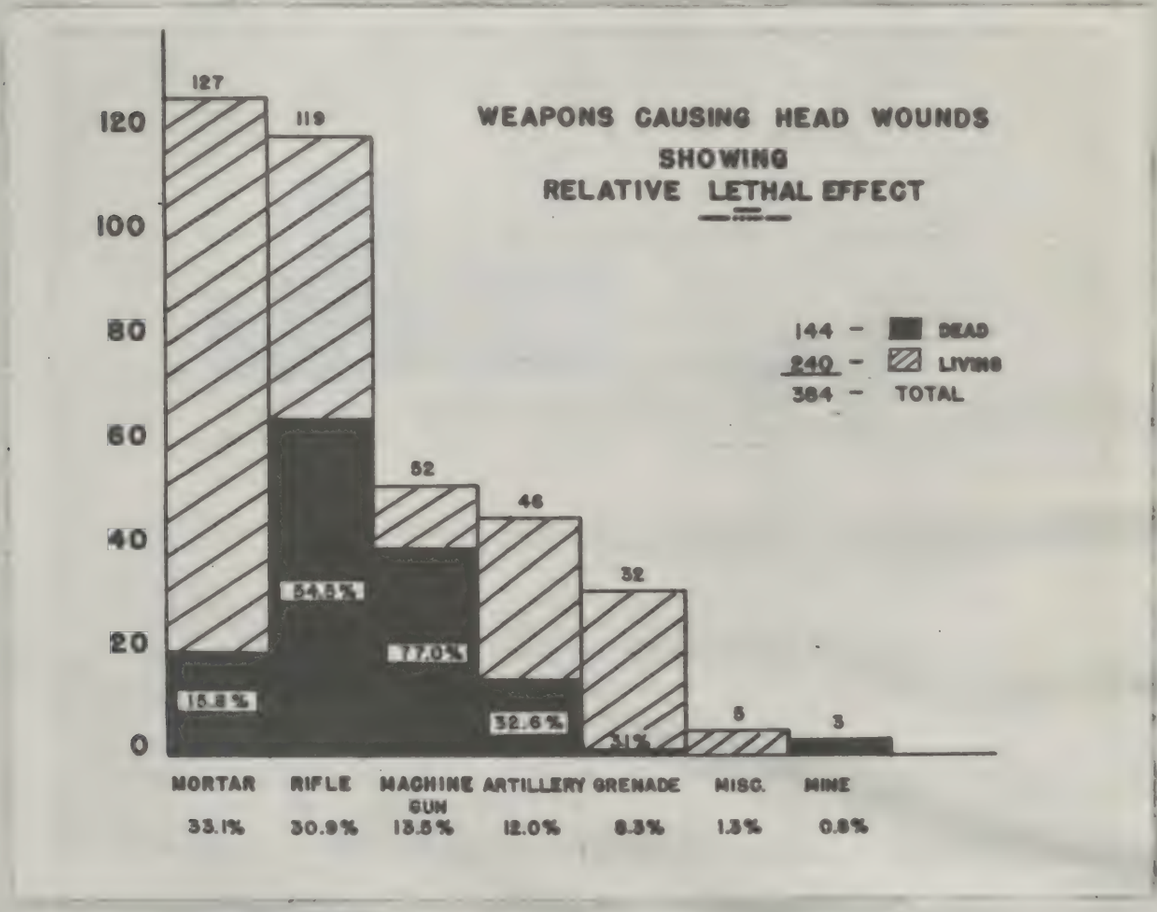


Fig.52

(b) Wounds of the Thorax

Wounds of the thorax accounted for 12.9 per cent of all casualties and for 22.0 per cent of all deaths. Excluding five wounded by miscellaneous weapons, high explosives produced 135 casualties (60 per cent), and bullets 91 (40 per cent). However, again contrasting relative lethal effects, bullets accounted for 59.7 per cent of the deaths, and high explosives for 40.3 per cent. In thoracic wounds the contrast between the lethal effect of wounds due to high explosives and bullets is not as pronounced as in wounds of the head. Possibly this is due to the fact that the thoracic cage offers less protection to the vital organs than does the skull and helmet. This hypothesis seems to be substantiated further by the fact that

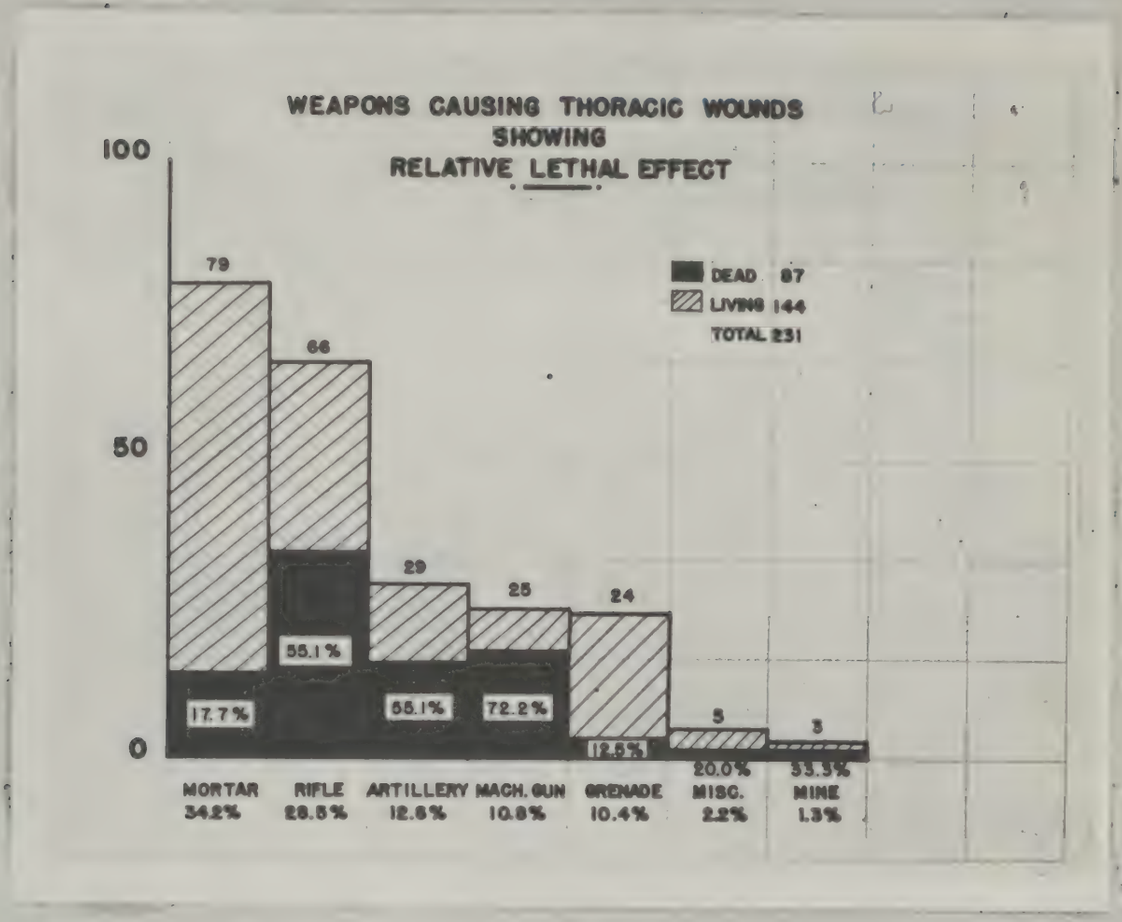


Fig.53

while the lethal effect of both mortar and artillery fragments is increased in the thorax, the lethal effect of the grenade is increased four fold. Bullet wounds were limited to the chest wall in only eighteen instances, while high explosives caused eighty five wounds which did not penetrate the thoracic cavity. The relatively lower velocity of the high explosive shell fragments would appear to account for its frequent failure to penetrate the thorax.

(c) Wounds of Abdomen

Casualties occasioned by wounds of the abdomen had the lowest incidence and accounted for only 6.6 per cent of the total wounded and 12.2 per cent of the dead. Whereas, high explosives caused 56.2 per cent of the casualties due to abdominal wounds, bullets accounted for 62.5 per cent of the deaths from these wounds. This ratio may represent a distorted picture when compared to findings in other theaters, since it is based on such a small number (8) of wounds of the abdomen caused by artillery shells. However, the mortar and the grenade show almost twice the relative lethal effect in wounds of the abdomen as they did in wounds of the thorax. This is further evidence that the bony structures of the body wall may offer considerable effective protection against these low

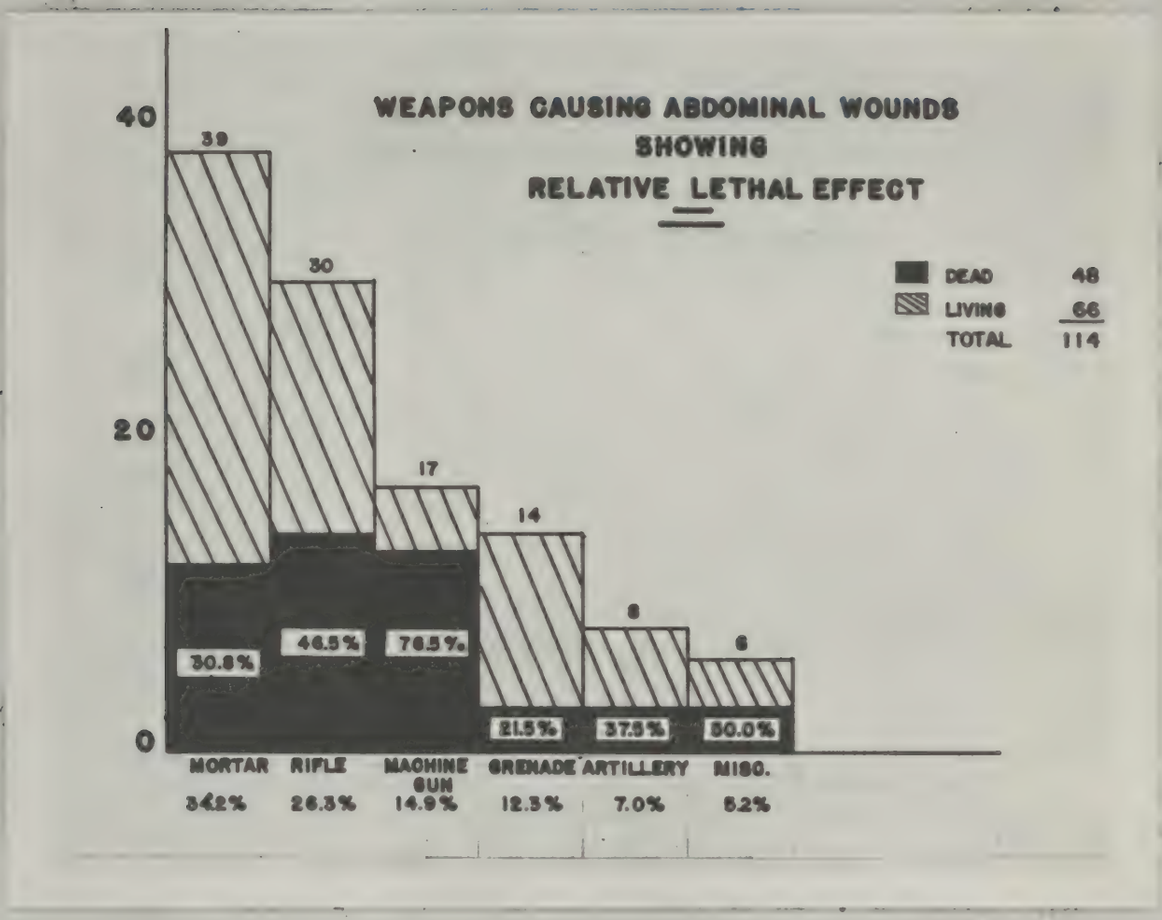


Fig.54

velocity fragments. High explosive fragments caused thirty of the fifty three wounds perforating the abdominal cavity, which would appear to indicate a relatively high index of penetration. Nevertheless, the relative protection afforded by the abdominal wall to low velocity fragments should also be mentioned. Thirty of the thirty eight wounds limited to the abdominal wall were caused by high explosive fragments.

(d) Wounds of Upper Extremity

Wounds of the upper extremity (Fig.55) account for 17.9 per cent of all casualties and for only 0.3 per cent of the dead. High explosive fragments caused 62.5 per cent of these wounds. More than half of all wounds caused by high explosives were due to mortar shells. The relative effectiveness of bullets and high explosive fragments may be judged from the severity of the wound as indicated by the disposition of the patients shown in the following table:

	Wounded by Bullets		Wounded by High Explosives	
	Number	Per Cent	Number	Per Cent
Duty 1st Echelon	44	35.7	131	66.8
Duty Rear Echelon	33	26.8	35	17.8
Evacuated to the U.S.	46	37.5	30	15.4

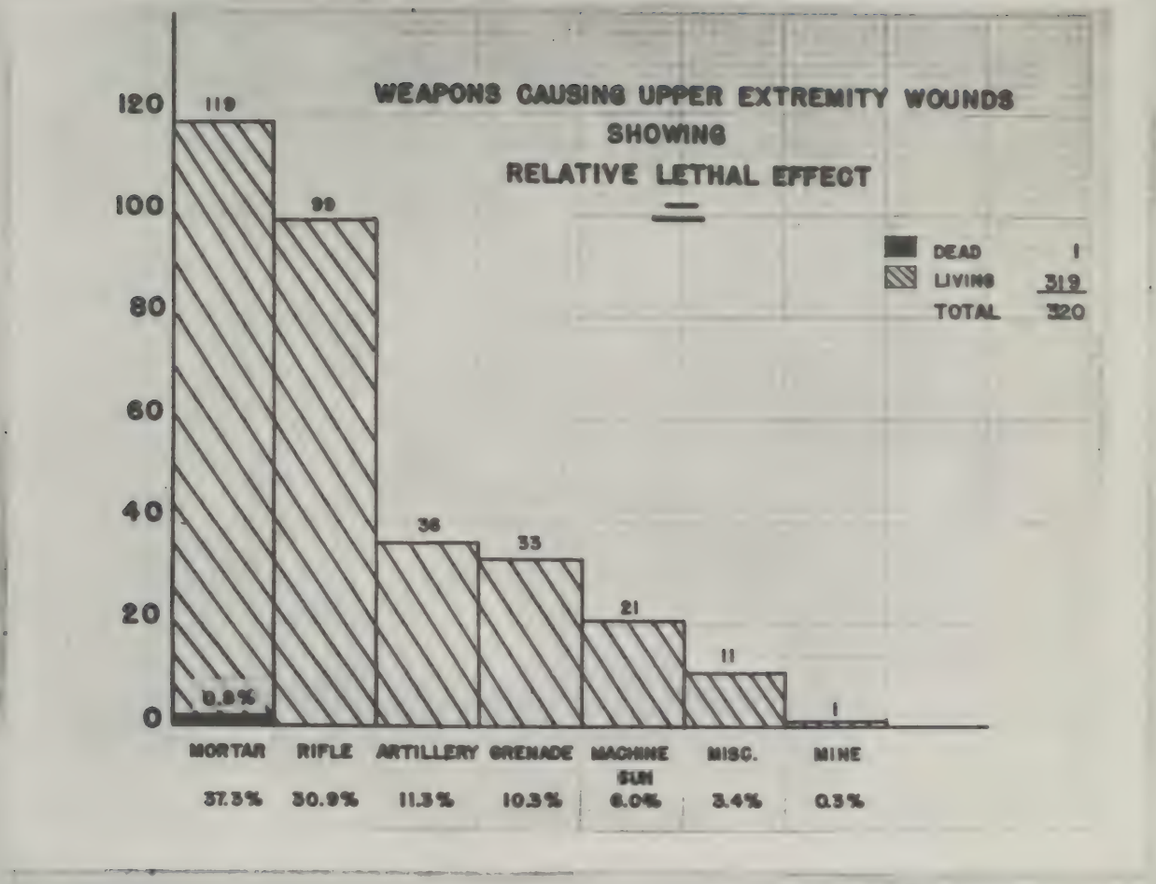


Fig.55

The one death among the upper extremity casualties was caused by a mortar shell. Since the lethal effect of wounds of the upper extremity was negligible, it deserves no discussion.

(e) Wounds of Lower extremity

Wounds of the lower extremity (Fig.56) caused the highest number of casualties (22.7 per cent). However, lower extremity wounds were responsible for only 3.5 per cent of all deaths. High explosives caused 72.5 per cent of lower extremity casualties, of these mortar shells alone were responsible for more than half. Bullets, however, caused eight of the fourteen deaths. The severity of wounds caused by bullets and high explosives may be judged by the following table showing the disposition of casualties:

	Wounded by Bullets		Wounded by High Explosives	
	Number	Per Cent	Number	Per Cent
Duty 1st Echelon	44	40.0	151	53.4
Duty Rear Echelon	30	27.3	83	29.3
Evacuated to the U.S.	36	32.7	49	17.3

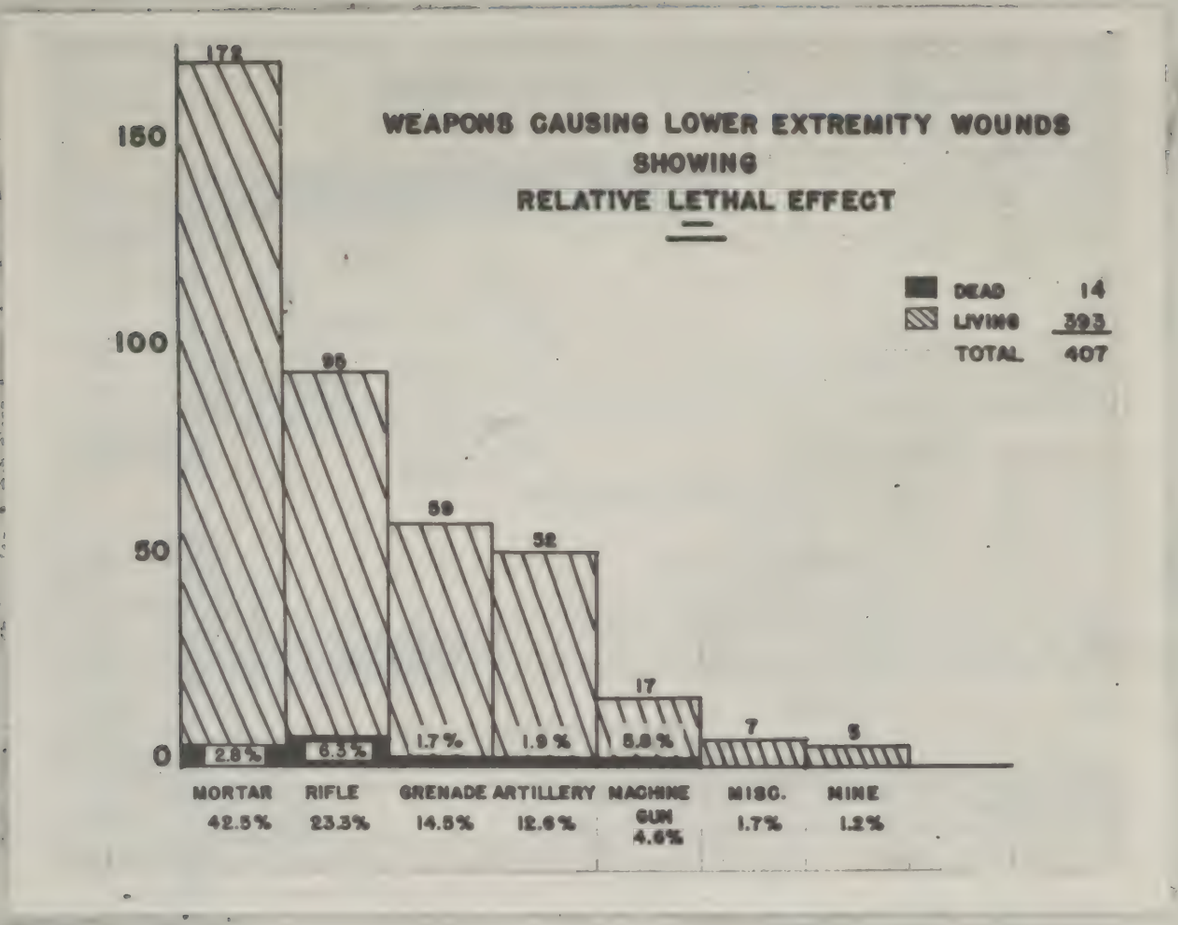


Fig.56

Of the entire number of casualties with lower extremity lesions lost to the service in the South Pacific by evacuation to the United States, 32.7 per cent were produced by bullets and 17.3 per cent by high explosives.

(f) Fractures

Wounds of the extremities constitute the largest group of battle casualties and account for 40.6 per cent of all wounds. These wounds, however, account for the smallest number of dead, only 3.8 per cent. Since relatively few deaths result from wounds of this region the effectiveness of weapons on the extremities must be judged by the duration of the soldiers incapacity and by the number of casualties lost to the service by evacuation to the rear echelon and to the United States. In view of the fact that fractures are the chief cause of evacuation to the United States, the relative effect of weapons on the extremities may also be judged by the number of fractures they cause. The rifle caused the greatest number of fractures in both the upper and lower extremities (Fig.57). In the upper extremity the rifle leads not only in the number but also in the percentage chance of fracture. In general the chance of fracture appears to parallel the velocity of the missile. Bullets caused only 37.5 per cent of upper extremity and 26.3 per cent of lower extremity wounds, whereas these missiles caused 66 per cent of upper extremity and 60 per cent of lower extremity fractures.

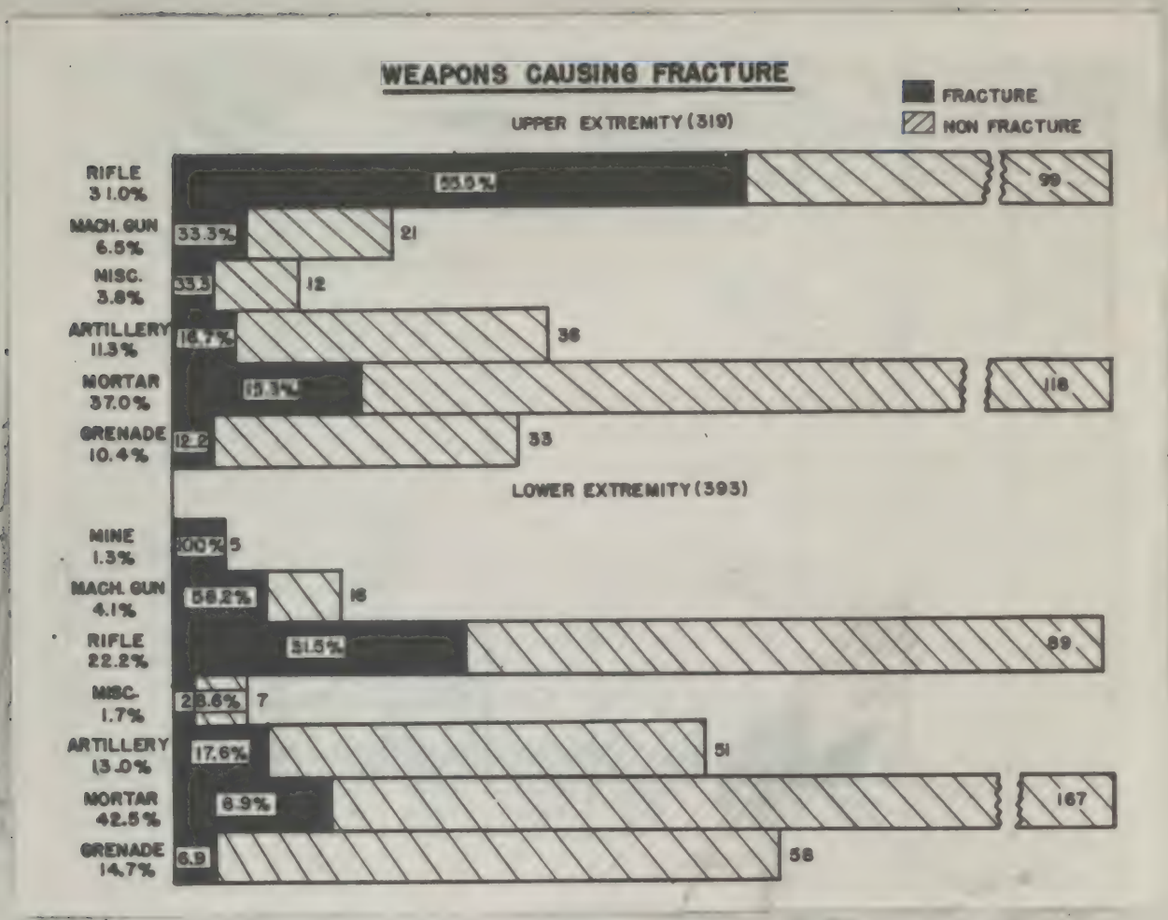


Fig. 57

This graph shows the distribution of fractures according to weapon. There were 319 living patients with wounds of the upper extremity and 393 with wounds of the lower extremity. The printed column at the left shows the percentage of wounds caused by each weapon.

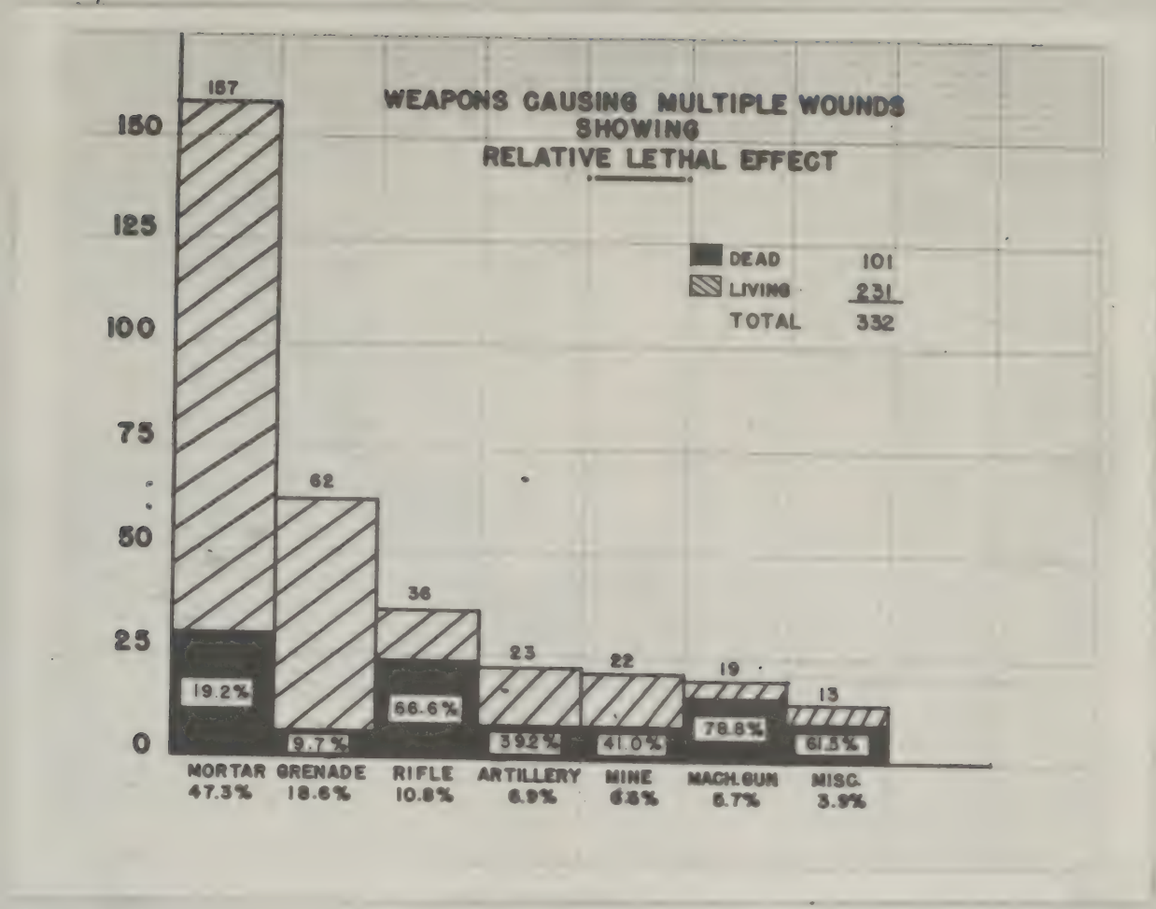


Fig. 58

(g) Multiple Wounds

Casualties due to multiple wounds rate third in incidence and constitute 18.6 per cent of the total number. High explosives caused 83.4 per cent of these wounds and 61.4 per cent of the resultant deaths, however, the machine gun and rifle showed the highest relative lethal effect. The part played by high explosives in the production of multiple wounds is further demonstrated in the following table:

	Wounded by Bullets		Wounded by High Explosives	
	Number	Per Cent	Number	Per Cent
Duty 1st Echelon	2	12.5	89	[illegible]
Duty Rear Echelon	8	50.8	74	[illegible]
Evacuated to the U.S.	6	37.5	[illegible]	[illegible]
	16	100.0	215	[illegible]

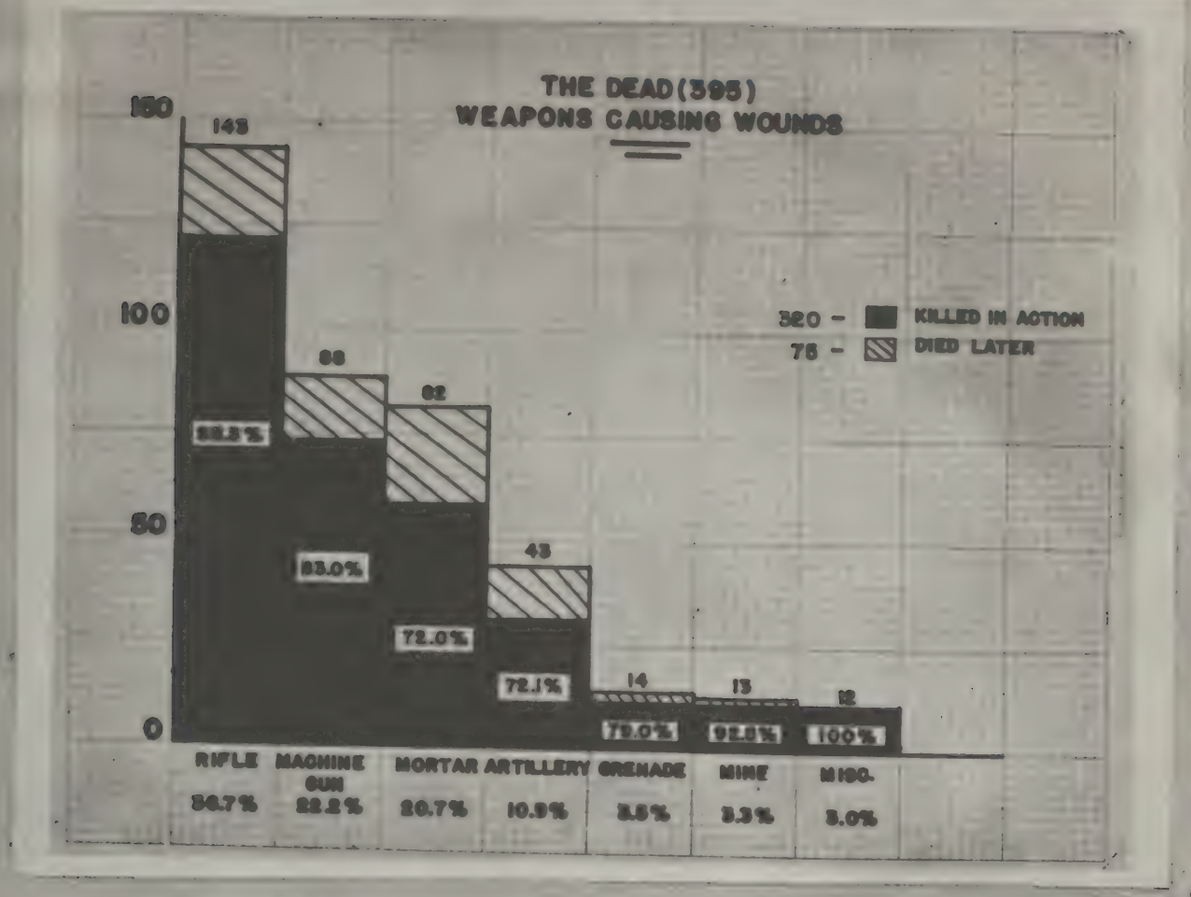


Fig.59 14

(h) The Dead

Fig.59 shows the distribution of the dead according to the causative weapon. There were 395 dead of whom 231 or 58.9 per cent were killed by bullets. Seventy five (19 per cent) of these 395 dead were wounded in action and died later. Fifty of the seventy five patients died within 24 hours; of these fifty, forty were classed as mortally wounded. Had medical facilities been further removed from the front line or transportation problems more difficult, no doubt a large number of those who were wounded and died later would have been classed as "killed in action". Bullet wounds tended to produce more immediate fatalities than did wounds produced by mortar and artillery shells. Among those who were wounded and died later, wounds were produced by the mortar in 27 per cent, by artillery in 28 per cent, and by the rifle in 14.5 per cent.

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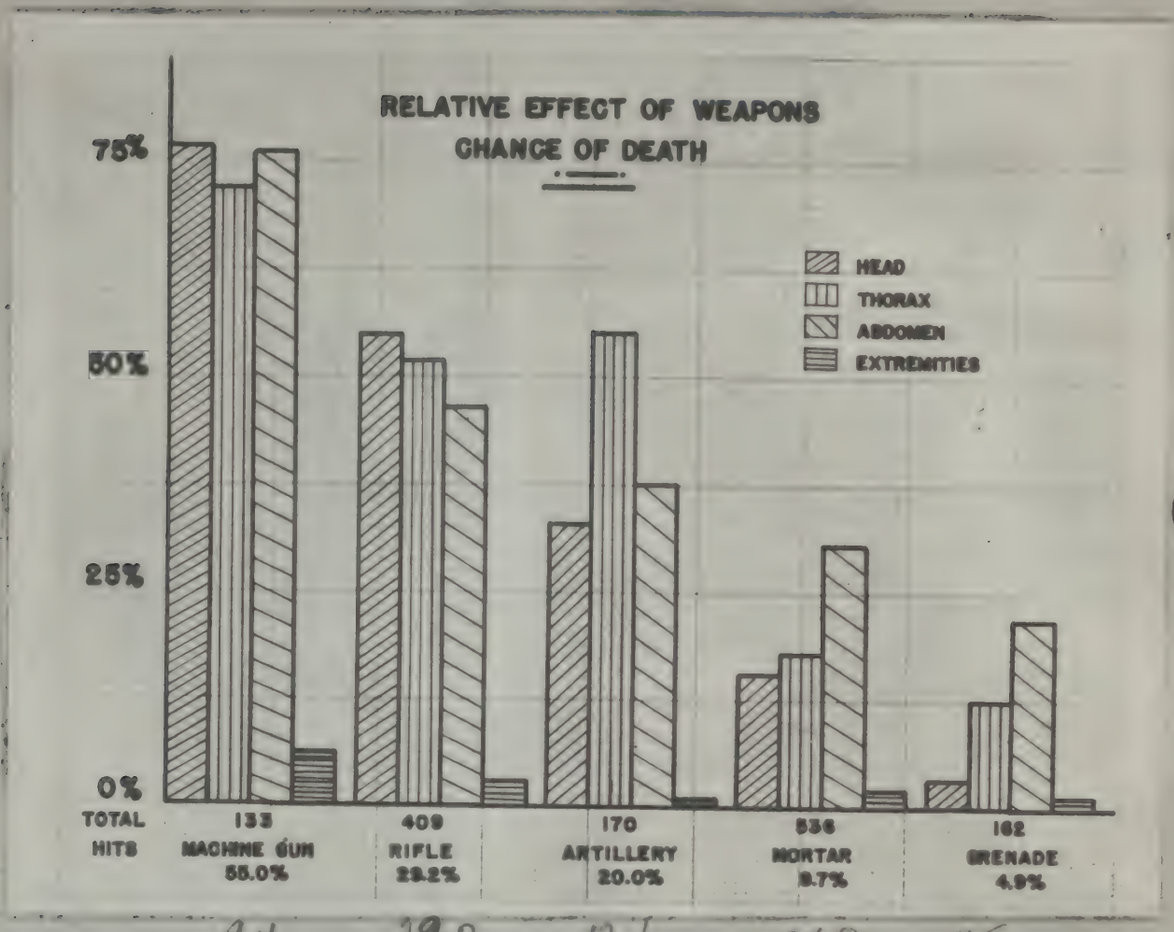


Fig.60

(i) Chance of Death

The percentage chance of death when hit by various weapons is shown in Fig.60. The order of these weapons suggests that the chance of being killed is a function of the velocity of the missile. The risk of death when hit by a machine gun in the head, chest, or abdomen is approximately equal. Casualties produced by more than two wounds either one of which might have produced death are not included in Fig.60, but are discussed under "Multiple Wounds". Nevertheless many of these casualties did have more than one wound. The contrast in death risk between the machine gun (55 per cent) and the rifle (29.2 per cent) is not entirely due to multiplicity of hits, since multiple hits were found not infrequently with rifle fire. On the average machine gun fire originated at a closer range than rifle fire, 61 per cent of the hits being from less than fifty yards. (A considerable number of this latter group of hits were at much longer ranges). The chance of death when hit by a grenade (4.9 per cent) is approximately half that when hit by the mortar (9.7 per cent). The risk of death when hit in the abdomen by mortar or grenade is relatively greater than when hit in the head or thorax. This suggests that the helmet and skull as well as the ribs may offer considerable protection against many of these relatively low velocity fragments.

(2) The Relative Effect of Weapons on the Disposition of Patients.

An evaluation of the effectiveness of each weapon may be obtained by considering both the number killed and the severity of the wound as determined by the disposition of the patient.

There were 676 casualties returned to duty from the first echelon (defined as the beachhead perimeter on Bougainville Island). These patients spent an average of 12.5 days in the hospital, ~~(Fig.61)~~, However, the majority if required would have been available for emergency combat duty in a shorter time. Nevertheless, the problem of the lightly wounded, treated in the first echelon, is of considerable importance, both because of days lost to the service and because these casualties occupy beds which might be needed for the more seriously wounded. Wounds caused by high explosive shell fragments constituted the major problem in the first echelon, ~~(Fig.61)~~. Wounds of the extremities and multiple wounds comprised a majority of these lesions. ~~(Fig.62)~~.

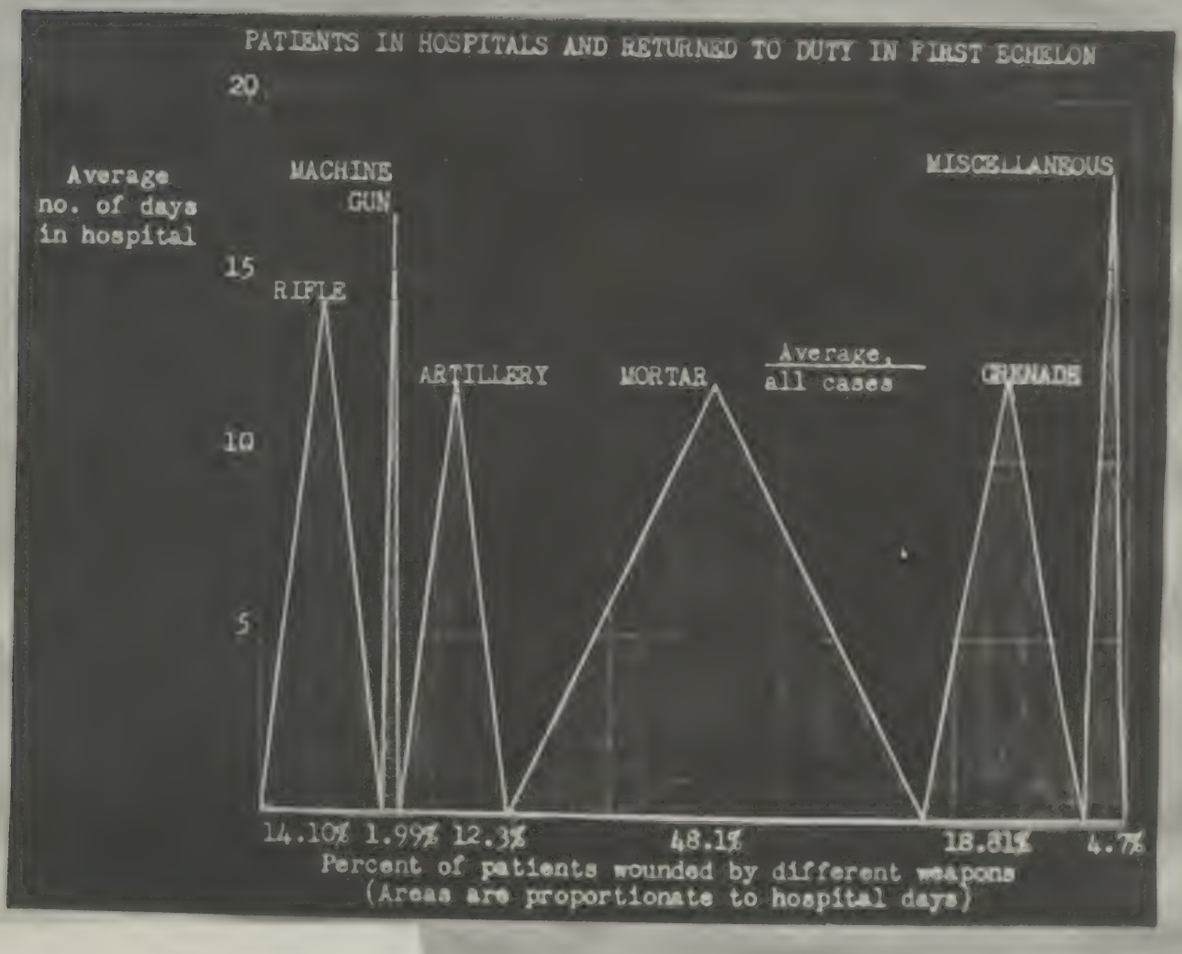


Fig.61

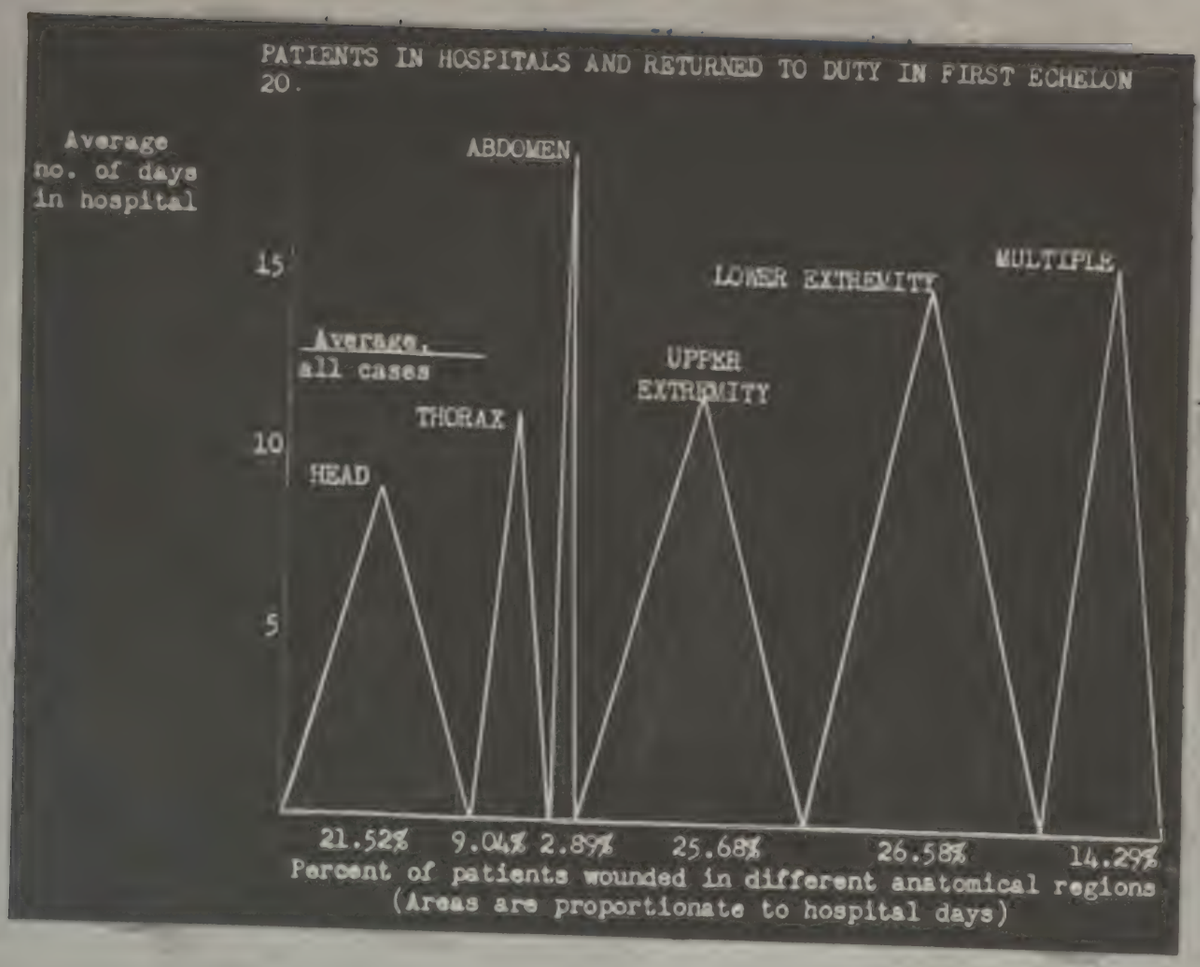


Fig.62

The rear echelon included hospitals on Guadalcanal, Espiritu Santo, and New Caledonia, 400 to 1,500 miles from Bougainville. Consequently patients evacuated to these hospitals were lost to the service in so far as this battle was concerned. Subsequently, however, some of these patients were returned to duty from the rear echelon and performed service in combat units, hence, were not lost to the South Pacific theater. The severity of the wounds in these casualties usually justified their removal to a rear echelon for convalescence. Only a very few were evacuated because of the need for additional vacant hospital beds on Bougainville. Hence, transfer to the rear echelon may be taken as a fair measure of the severity of a soldier's wound from the standpoint of his ability to undergo combat. The wounded were usually returned to duty from the rear echelon or evacuated to the United States within 120 days. However, the average elapsed time before return to duty was considerably less than this.

While many patients evacuated to the United States may return to duty eventually, they must be considered as lost to the service for a long period.

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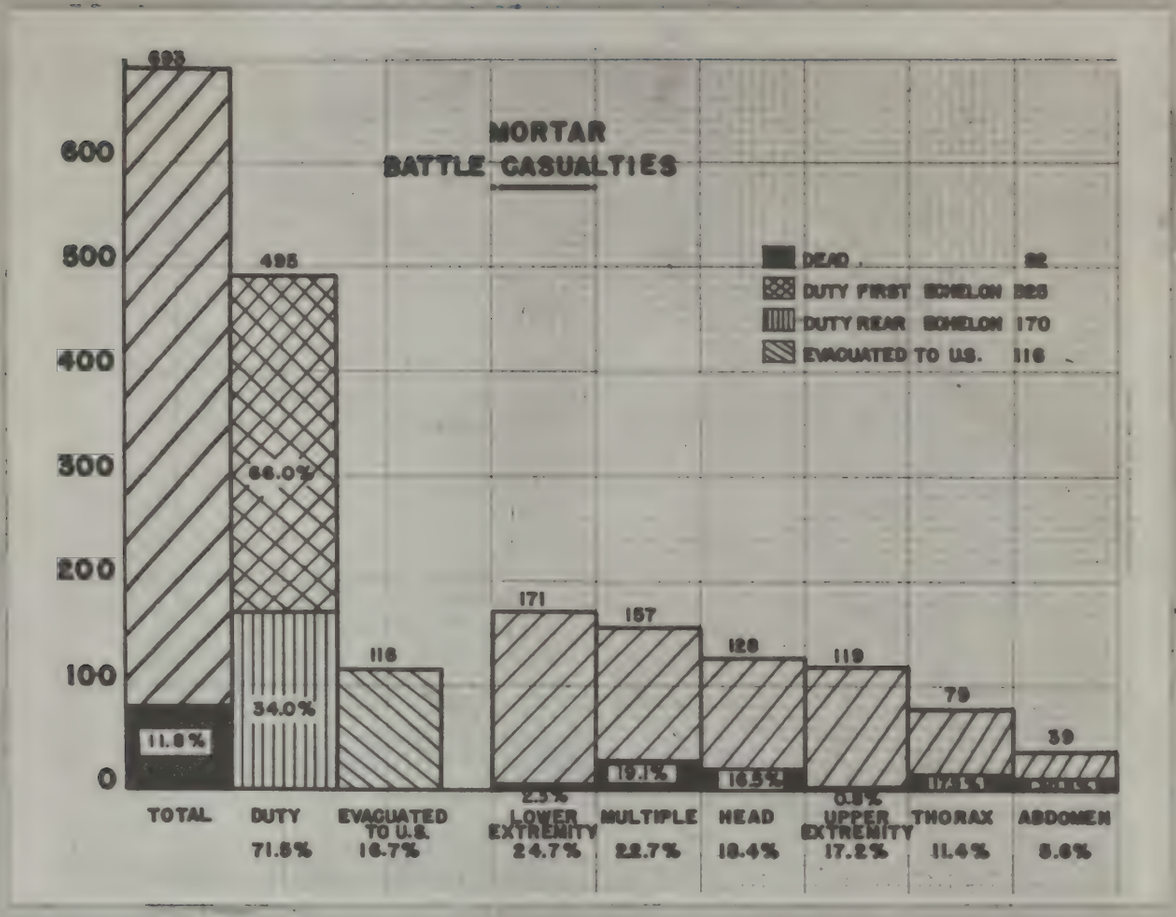


Fig.63

(a) Mortar

The mortar caused more wounds than any other weapon and accounted for 38.7 per cent of all battle casualties. However, its relative lethal effect was only 11.8 per cent. The only weapon having a lower lethal effect was the grenade. Furthermore 71.5 per cent of the living wounded were returned to duty, a higher percentage than for any other weapon except the grenade. The dead and evacuated to the United States ("lost to the service") totalled 28.5 per cent. The percentage of casualties produced by the mortar by region wounded in order of frequency follows: lower extremity (24.7 per cent), multiple (22.7 per cent), head (18.4 per cent) and upper extremity (17.2 per cent). The highest relative lethal effect (30.8 per cent) is observed in wounds of the abdomen, whereas, the greatest number of deaths occurred in "multiple wounds".

(b) Rifle

In number of wounds produced the rifle was exceeded only by the mortar and was responsible for 24.8 per cent of all battle casualties. However, the rifle ranked first as a lethal agent accounting for 36.7 per cent of all dead. Moreover, it was second in percentage relative lethal effect, being exceeded only by the machine gun. The rifle

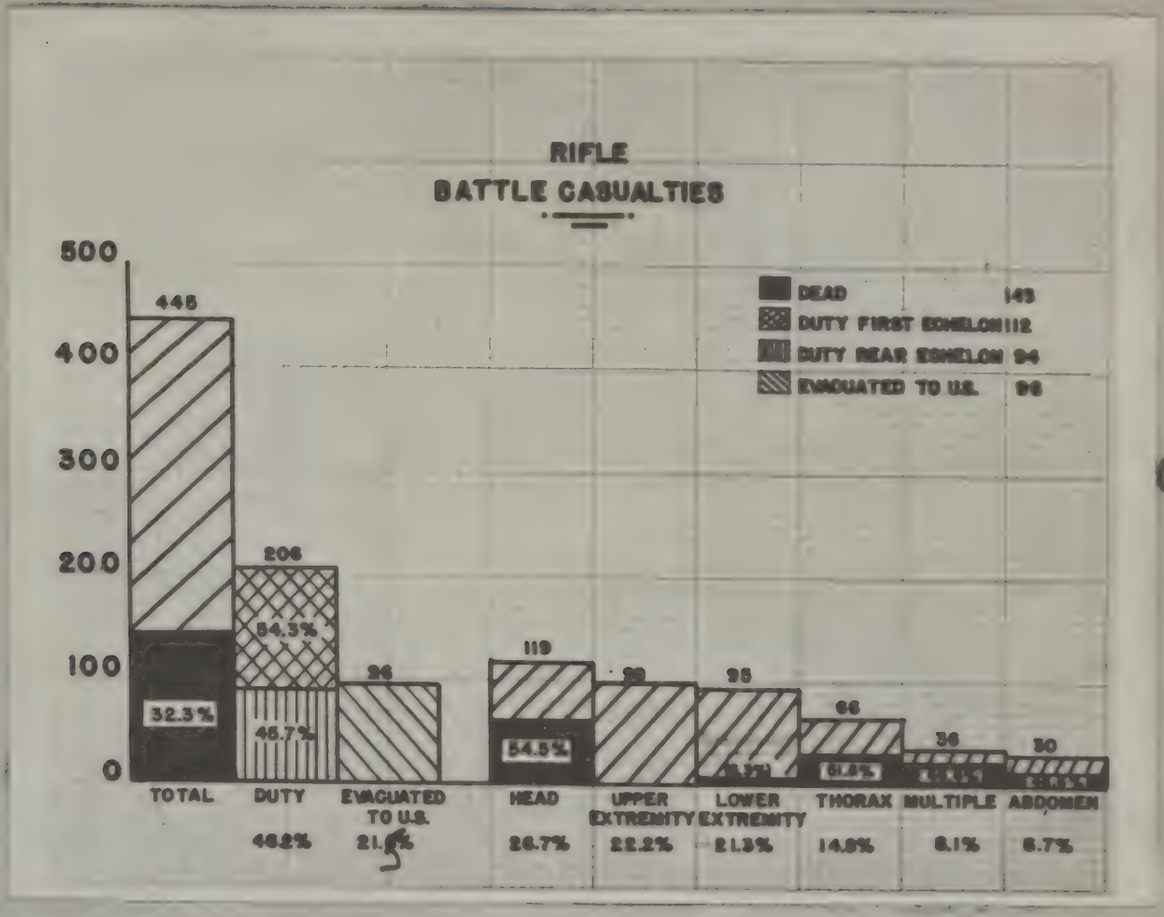


Fig.64

produced wounding in 53.8 per cent of all casualties lost to the service by death and evacuation to the United States. The rifle caused more head wounds than any other weapon and was second only to the machine gun in relative lethal effect in head wounds. It ranked third in relative lethal effect in thoracic wounds being exceeded by the machine gun and artillery shell and second in abdominal wounds. While the rifle was second to the mortar in causing wounds of both the upper and lower extremities, it produced more fractures than any other weapon.

(c) Grenade

The grenade ranked third in wound production and accounted for 12.5 per cent of all battle casualties (Fig.65). However, its relative lethal effect was the lowest of all weapons, 6.2 per cent. Furthermore the majority of the wounds were of a minor nature. The grenade was first among all weapons as gauged by the percentage of wounded returned to duty, 77.3 per cent, and three fourths of these patients were returned to duty from the first echelon. The grenade was responsible for the lowest number of casualties (22.7 per cent) among those who were lost to the service by death and evacuation to the United States. Of all wounds produced by the grenade, 68.7 per cent were classified as extremity wounds and multiple wounds.

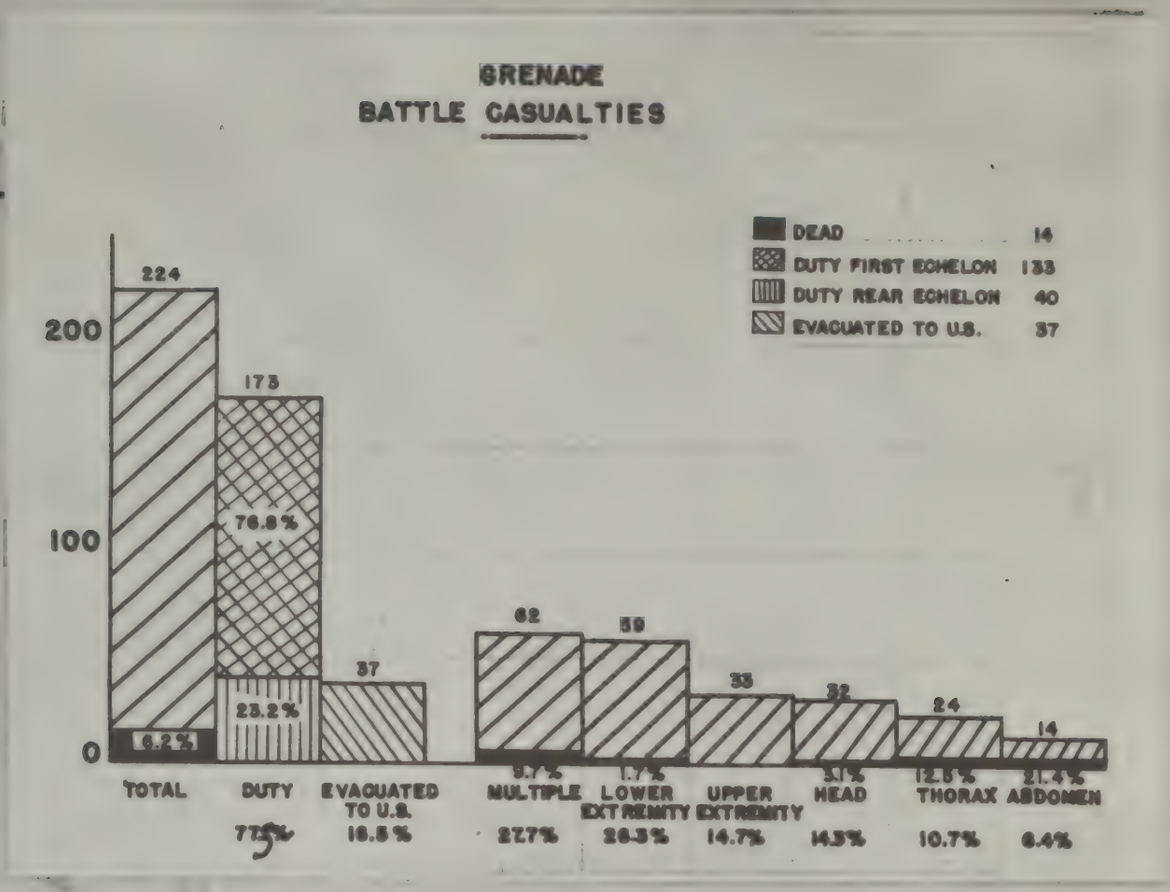

GRENADE
BATTLE CASUALTIES
DEAD 14
DUTY FIRST ECHELON 133
DUTY REAR ECHELON 40
EVACUATED TO U.S. 37
200
100
0
224
173
76.8%
23.2%
37
6.2%
62
59
33
32
24
14
9.7%
1.7%
5.1%
12.5%
21.4%
TOTAL
DUTY
EVACUATED TO U.S.
MULTIPLE
LOWER EXTREMITY
UPPER EXTREMITY
HEAD
THORAX
ABDOMEN
77.2%
16.8%
27.7%
26.3%
14.7%
14.3%
10.7%
6.4%

Fig. 65

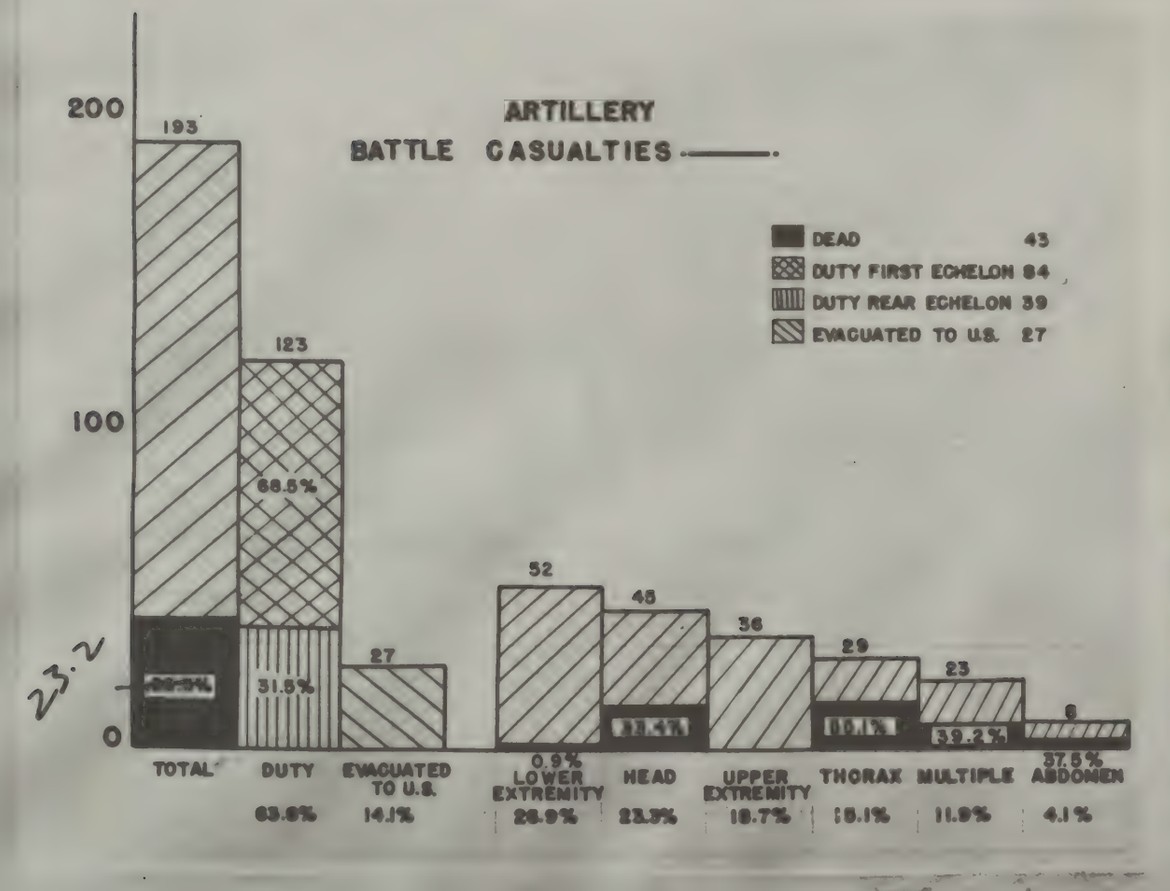

ARTILLERY
BATTLE CASUALTIES
DEAD 43
DUTY FIRST ECHELON 84
DUTY REAR ECHELON 39
EVACUATED TO U.S. 27
200
100
0
193
123
68.5%
31.5%
27
52
45
36
29
23
6
0.9%
33.4%
59.1%
39.2%
37.5%
TOTAL
DUTY
EVACUATED TO U.S.
LOWER EXTREMITY
HEAD
UPPER EXTREMITY
THORAX
MULTIPLE
ABDOMEN
63.8%
14.1%
26.9%
23.3%
18.7%
15.1%
11.9%
4.1%

Fig. 66

(d) Artillery

The use of artillery by the enemy in this campaign was relatively limited. Wounds caused by artillery shells, however, accounted for 10.8 per cent of the casualties and were fourth in frequency. Artillery ranked fourth in cause of death and third in percentage lethal effect, 23.2 per cent. Among casualties evacuated to the United States artillery produced the lowest number of wounds, 14.1 per cent. However, the percentage of those lost to the service by death and evacuation to the United States was 30.4 per cent. While wounds of the extremities were frequent, only one death occurred. This death was produced by a lower extremity wound. Lethal wounds in order of frequency by regions were: thorax, head, multiple and abdomen.

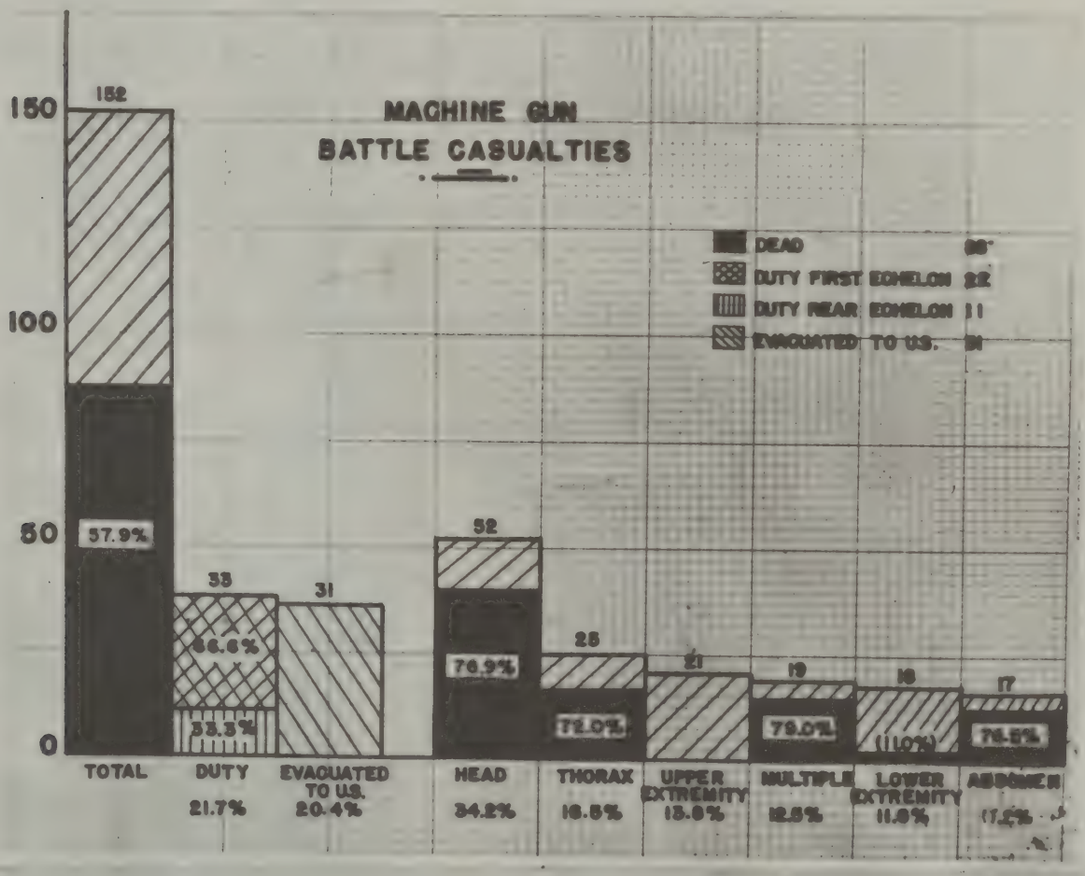


Fig.67

(e) Machine Gun

The machine gun caused fewer casualties than any other weapon, 8.5 per cent. However, its percentage relative lethal effect was the highest of all weapons, 57.9 per cent. It was not possible to separate the casualties

produced by the 6.5 mm weapon from those produced by the 7.7 mm machine gun. The percentage lost to the service by death and evacuation to the United States was also the highest of any weapon, 78.3 per cent. Measured by the number of patients lost to the service machine gun wounds were the most severe among those produced by any weapon. This high degree of effectiveness of the machine gun bullet may be explained partially by close range fire in this campaign and also by the multiplicity of wounds. The percentage relative lethal effect was uniformly high for all regions of the body with the exception of the extremities.

(f) Multiple Wounds

The question has been frequently asked, do multiple missiles causing multiple wounds result in more serious casualties, because of the number of wounds per se? The data available does not answer this question satisfactorily. Multiple wounds were analyzed according to the number of different anatomical regions involved, rather than by the total number of wounds. Thus a patient with ten wounds of the leg and five of the hand was classified under multiple wounds in two anatomical regions, as an upper and a lower extremity casualty without regard to the number of lesions present.

Using the criterion of the number of different anatomical regions involved, the following tables were derived:

Table 37

MULTIPLE WOUNDS SHOWING RELATION BETWEEN NUMBER OF MEN, NUMBER OF ANATOMICAL REGIONS HIT AND SEVERITY OF WOUNDS (AS JUDGED BY DISPOSITION)

	Number of Patients				Number of Anatomical Regions Hit			
	1st Echelon	Rear Echelon	To U.S.	Total	1st Echelon	Rear Echelon	To U.S.	Total
Mortar	53	41	33	127	117	99	85	301
Grenade	29	16	11	56	70	40	29	139
Land Mine	2	7	5	14	4	20	16	40
Art.Shell	4	6	3	13	9	12	8	29
Rifle	2	7	3	12	4	17	7	28
Mach.Gun	0	1	3	4	0	3	8	11
Total	90	78	58	226	204	191	153	548

RATIO OF NUMBER OF ANATOMICAL REGIONS HIT PER PATIENT EVACUATED IN EACH ECHELON ACCORDING TO WEAPON

	Duty 1st Echelon	Duty Rear Echelon	Evacuated To U.S.	Total
Mortar	2.21	2.41	2.58	2.37
Grenade	2.41	2.50	2.64	2.48
Land Mine	2.00	2.86	3.20	2.86
Art. Shell	2.25	2.00	2.67	2.23
Rifle	2.00	2.43	2.33	2.33
Mach.Gun	--	3.00	2.67	2.75
Total	2.27	2.45	2.64	2.44

The disposition of the patient was used to determine the severity of the wounds. The number of the multiple wounded casualties discharged in each echelon is tabulated by weapon. The corresponding number of anatomical regions hit is also recorded by weapon. Thus there were fifty three patients with mortar wounds in one hundred and seventeen different anatomical regions, returned to duty in the first echelon. Therefore, among the patients returned to duty in this echelon there were mortar wounds 2:21 of the various anatomical regions per patient. The ratio of anatomical regions wounded per patient is slightly higher for each weapon among the casualties evacuated to the United States. However, the difference is so slight as to suggest that multiplicity of wounds alone is not a factor of great importance. The relatively low mortality of 3.3 per cent for all patients with multiple wounds seen alive suggests that the multiple wounds per se add little to the risk. It is likely that the actual severity of the wound is the more important factor in determining death and disability. It would be desirable, however, to have data which include a count of the actual number of wounds by anatomical region in both the living and the dead.

(g) Effectiveness of Weapons

To measure the effectiveness of a weapon by the number of casualties it produces may lead to erroneous conclusions. To reiterate, the number of casualties depends on such factors as, the necessary exposure of the soldier, the concentration of troops, the number of weapons employed and the effect of the missile. It is seldom that all these varying conditions of battle can be duplicated. On the other hand the percentage chance of death, and the length of disability when hit by a given weapon should remain relatively

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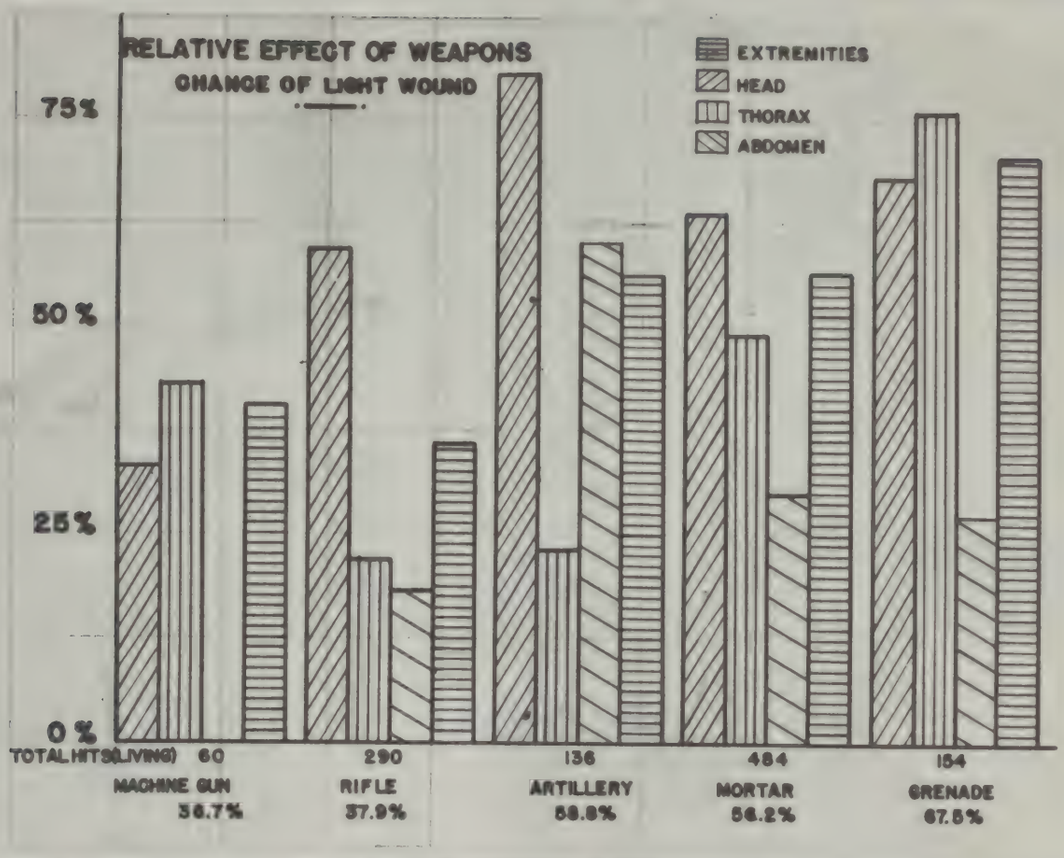

RELATIVE EFFECT OF WEAPONS
CHANCE OF LIGHT WOUND
EXTREMITIES
HEAD
THORAX
ABDOMEN
75%
50%
25%
0%
TOTAL HITS(LIVING) 60 290 136 484 154
MACHINE GUN 56.7%
RIFLE 37.9%
ARTILLERY 58.8%
MORTAR 56.2%
GRENADE 67.5%

Fig.68

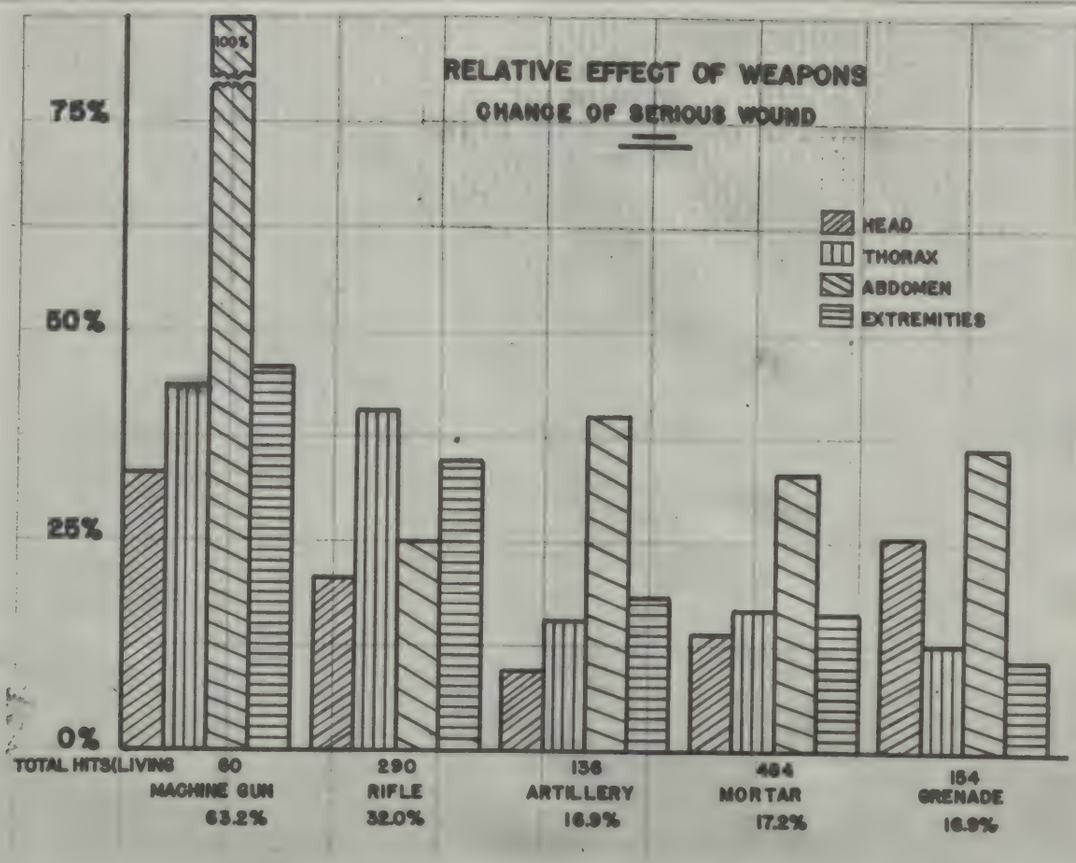

RELATIVE EFFECT OF WEAPONS
CHANCE OF SERIOUS WOUND
100%
HEAD
THORAX
ABDOMEN
EXTREMITIES
75%
50%
25%
0%
TOTAL HITS(LIVING 60 290 136 484 154
MACHINE GUN 63.2%
RIFLE 32.0%
ARTILLERY 16.9%
MORTAR 17.2%
GRENADE 16.9%

Fig.69

constant, and, therefore, should offer a fairly accurate index of the effectiveness of various missiles.

The relative effect of weapons may be judged by the percentage chance of a light wound or of a severe wound. (Figs.68 and 69). (These charts are based on living wounded only. A light wound was defined as one which allowed return to duty in the first echelon, and a severe wound as one which necessitated evacuation to the rear echelon or to the United States). The average percentage chance is given below each weapon. There appears to be considerable difference in the severity of a wound according to the anatomical region hit, as well as to the weapon causing it. In general high explosives tend toward light wounds, while bullets tend toward more severe wounds.

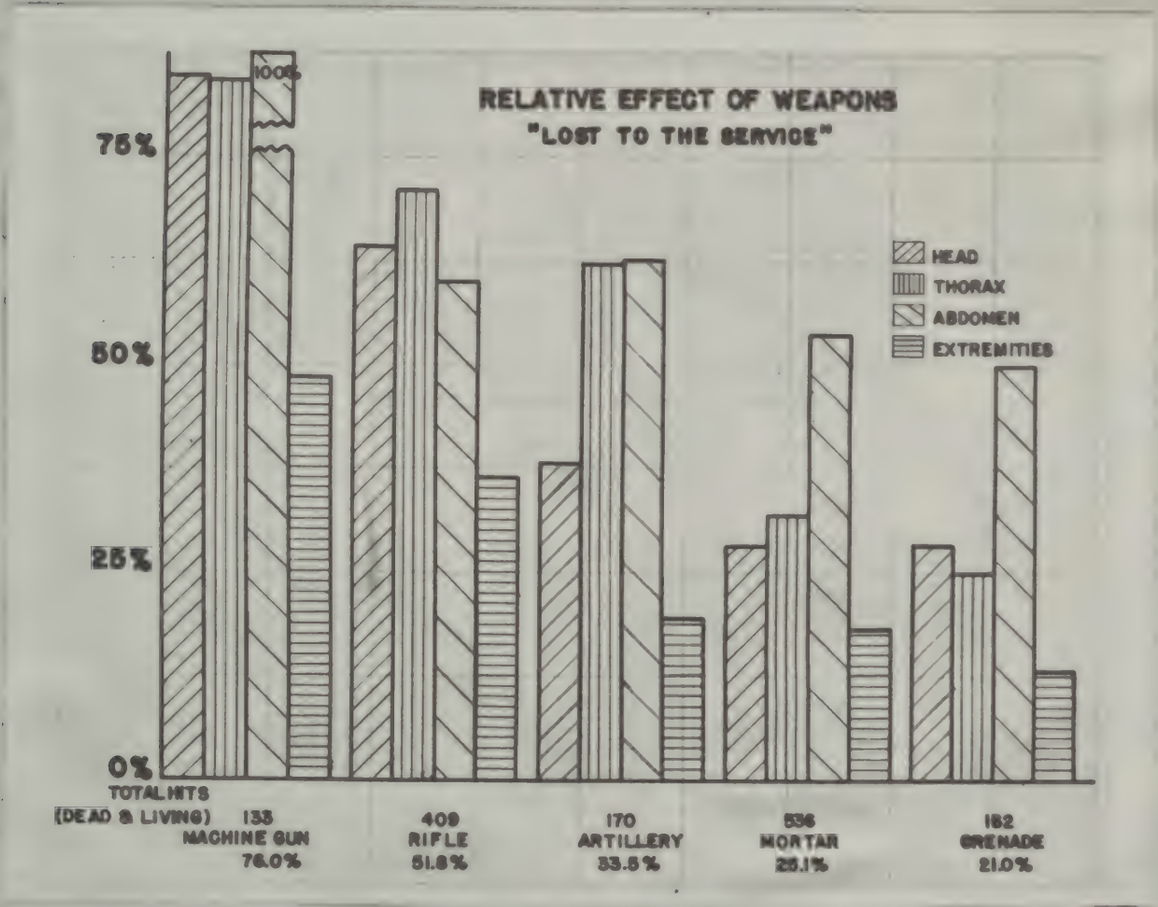


Fig.70

The relative effectiveness of weapons may also be evaluated by a consideration of the total dead plus the total evacuated to the United States. Together these may be considered as "lost to the service", (Fig.70) although some who were returned to the United States may serve in future campaigns. It should be noted that by this criterion wounds of the extremities and abdomen assume a far greater relative importance than when death alone is utilized as an index of weapon effectiveness.

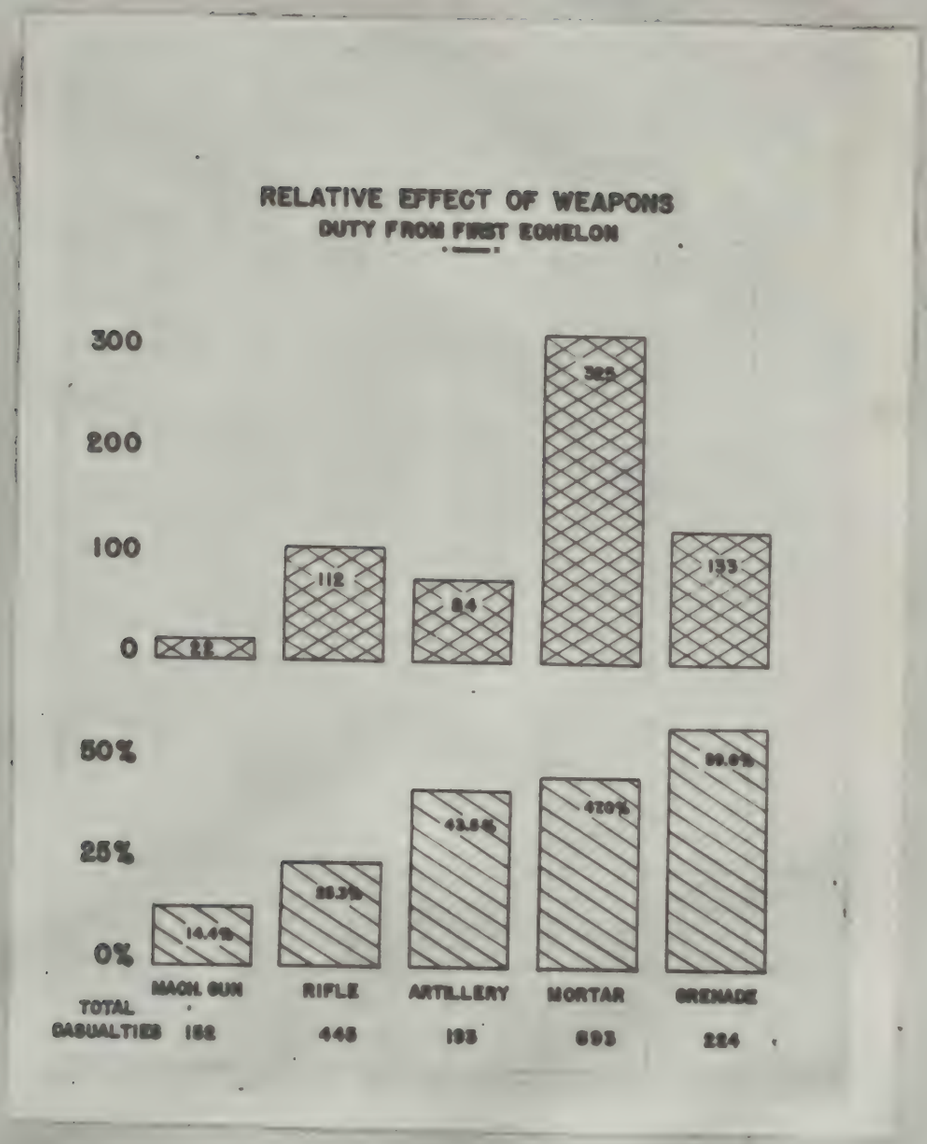


Fig.71

The upper section of the graph shows the number of patients returned to duty from the first echelon (Bougainville). The bottom section shows the percentage of patients hit by each weapon who were returned to duty from the first echelon. The total number of casualties hit by the different missiles are shown on the bottom line.

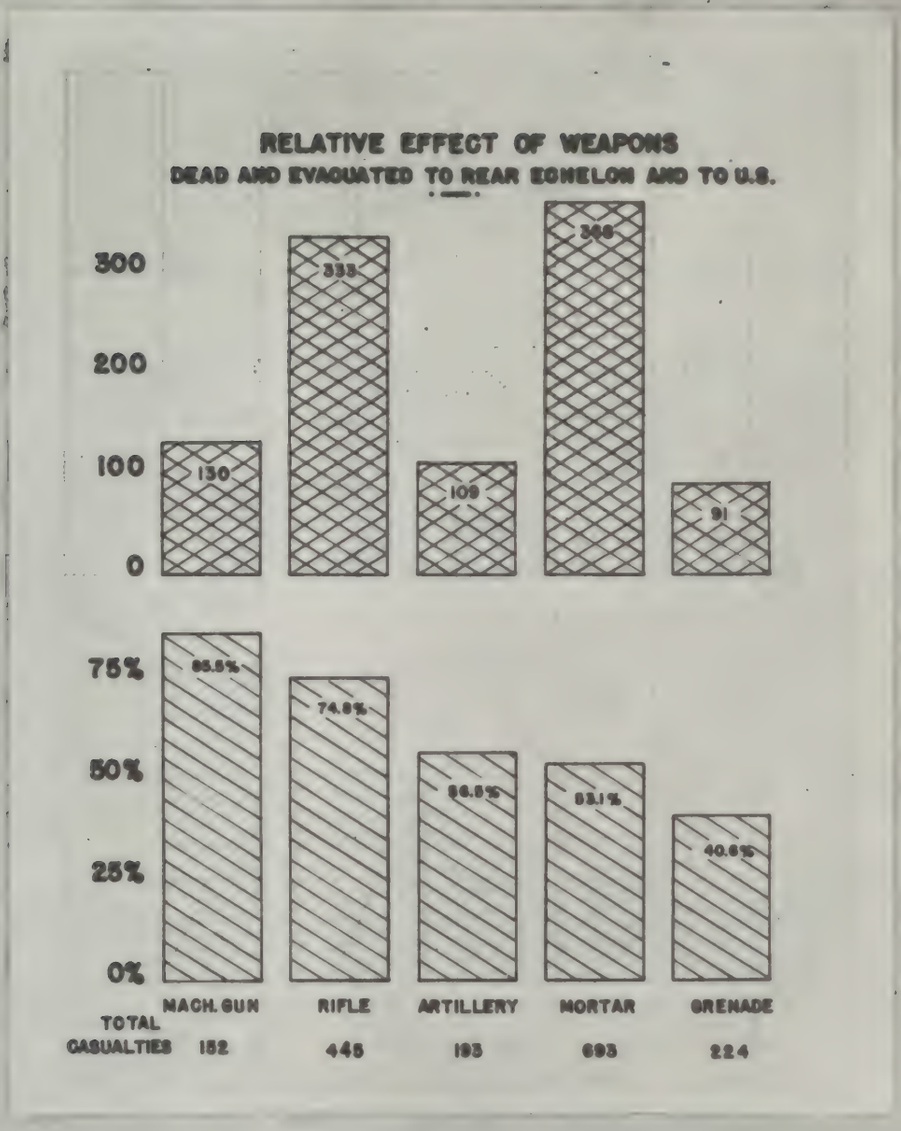


Fig.72

The total number of casualties dead, evacuated to the rear echelon and to the United States are shown in the top section of the graph. These were "lost to the Bougainville Campaign". The bottom section shows the percentage of casualties caused by the different weapons who were killed, evacuated to the rear echelon, and to the United States. Note that the percentage effectiveness of each weapon suggests a possible correlation with the average velocity of hits.

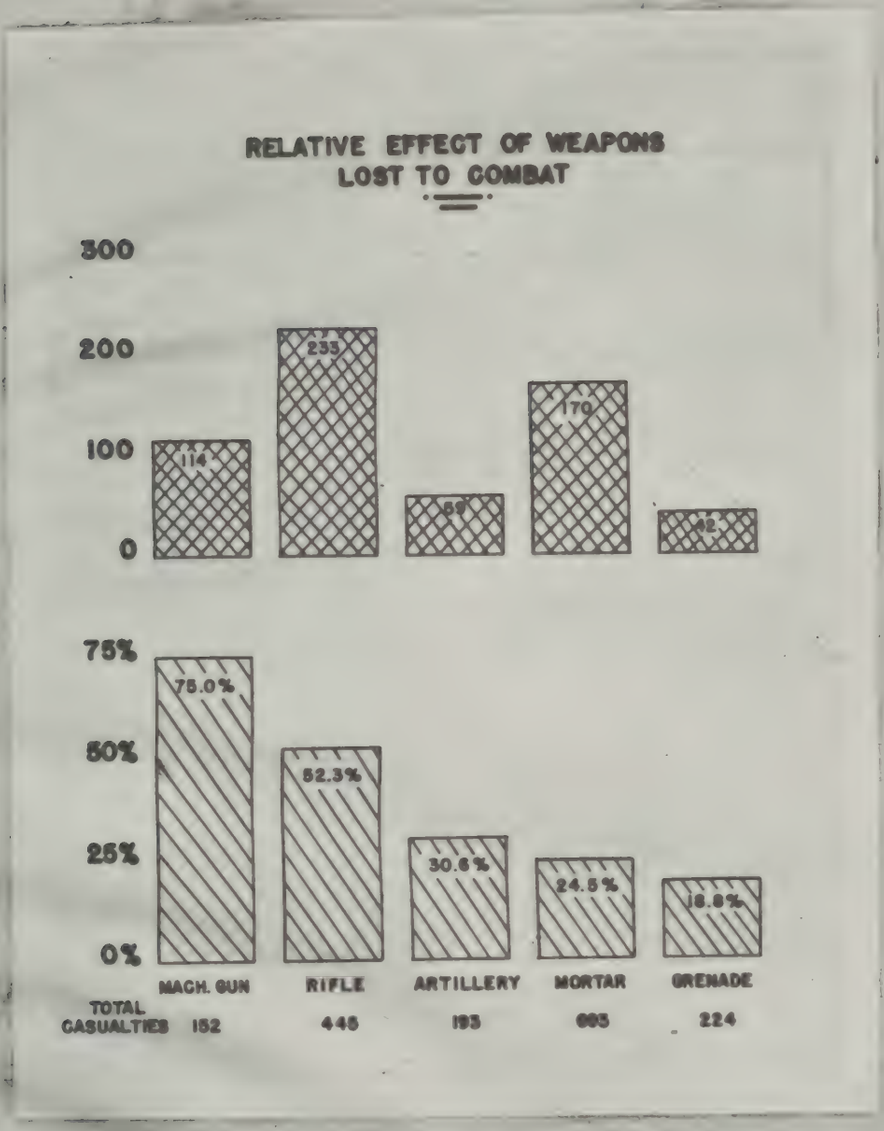


Fig.73

Conditions of battle may be such that the effectiveness of a weapon can be best measured by whether the wounded soldier is able to continue fighting. Hence, the number of casualties per se is not a sufficient criterion since many of them may continue to fight and hold off the enemy at least temporarily. It was, therefore, desirable to know the number who are put out of action immediately and the number who could continue combat for a period of hours, if life depended on it. A questionnaire to determine whether an individual did or did not continue combat was found to be misleading, since conditions of battle were frequently such as to permit the soldier to seek immediate treatment. This he usually did when possible, since he had been so instructed by the Medical Corps. However, there were numerous instances of soldiers who were severely wounded and yet who continued to hold their position in the line until relieved. (e.g. Two soldiers were holding a pillbox at night under Japanese attack. Eventually each had a hand blown off, but with two hands between them, they cared for their wounds, manned their guns and held off the attack until relieved at daybreak).

An arbitrary criterion based on the seriousness of the wound seemed justified in order to determine whether a soldier will be able to continue in battle for a number of hours, if his life were at stake. For this purpose an arbitrary schedule was derived and the following wounded were classed as "Lost to Combat".

1. Wounds of the head and CNS producing unconsciousness or paralysis.

2. Wounds of intrathoracic structures producing hemorrhage and shock.

3. Wounds of intraperitoneal structures producing hemorrhage and shock.

4. Wounds of the extremities producing fractures of long bones, severance of major blood vessels or major traumatic amputations.

5. Extensive wounds of soft tissue producing shock.

The wounded were classified according to the above criteria and added to the dead to determine the total "lost to combat" (Fig.73). The lower section of this graph again suggests that the percentage effectiveness of the weapon is a function of the average velocity of the hits.

Callender and others have shown that the wounding power of a missile is in proportion to the cube of the velocity, the mass and other factors being equal. In this report the percentage effectiveness of weapons as judged by the chance of death, and the severity of the wound, appears to be in accord with the observation that the wounding power of a missile is chiefly a function of velocity. When hits occur the weapons in order of effectiveness are (1) machine gun, (2) rifle, (3) artillery, (4) mortar, and (5) grenade.

(3) Wounds Caused by U.S.Weapons

It had been the intention of the ballistic team to study the effect of U.S. weapons on the enemy dead. Unfortunately this plan was found impracticable because of difficulty in obtaining the enemy dead before decomposition had occurred and also because of the paucity of team personnel. Certain local conditions prevailed which circumvented accuracy in such a study. In the first place, due to the character of the fighting and our extensive use of artillery and mortar fire, the enemy dead were frequently struck by many different missiles before the bodies could be recovered. Furthermore, it was impossible to obtain any detailed information regarding the circumstances surrounding death.

It was possible, however, to investigate the effect of U.S. weapons on a limited number of our soldiers who were wounded. There were 219 casualties (12.3 per cent of the total) due to our weapons in the hands of our own troops. While the Japanese used some of our weapons particularly rifles and grenades, as a rule it was impossible



to know when this occurred. Among our forces there were sixty three deaths (16.0 per cent of the total dead) produced by U.S.weapons.

Mortar and artillery fire accounted for fifty-five of the wounded and twenty one of the dead. Among these, thirteen were killed and forty wounded by mortar and artillery "shorts". Eight died among the sixteen casualties who were wounded on patrol by our artillery.

There were fifty two casualties caused by the rifle, sixteen of whom died. Nineteen were wounded by the accidental discharge of a rifle by a fellow soldier. Mistaken identity resulted in thirteen deaths and the wounding of six others. Eight of these deaths were occasioned by the soldier seeking to relieve himself at the toilet during the night. Self-inflicted wounds, accidental or intentional, were responsible for ten casualties, three of whom died. The accidental tripping of land mines and booby traps produced fourteen deaths in a total of forty wounded. Eight soldiers were killed and four wounded by hand grenades other than those used in booby traps. Miscellaneous weapons including bangalore torpedoes, bombs, pistols, knives and powder explosions accounted for thirty eight casualties. Of these seven were fatal.

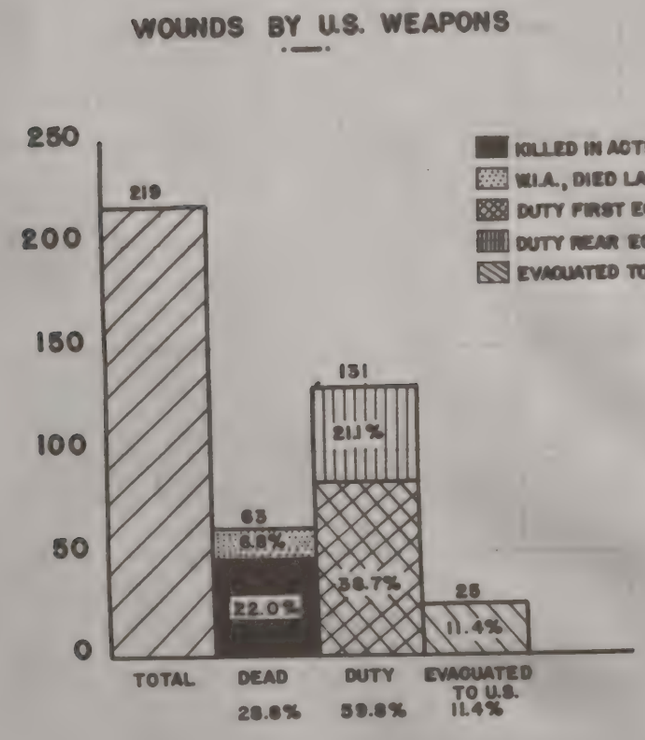


Fig. 74

The disposition of all casualties produced by our weapons is shown in Fig.74. While the number of these casualties is too small to allow adequate comparison between the effect of Japanese and U.S.weapons, nevertheless, it is utilized, being the only available data. (Figs.75 and 76). It is evident that the relative lethal effects of the Japanese mortar and rifle are essentially similar to the lethal effects of these same U.S. weapons. However, the relative lethal effect of U.S.artillery is ~~40.5~~ per cent, while that of the Japanese artillery is only 17.2 per cent. A possible explanation for this discrepancy may lie in the proportion of different weapons employed by the opposing forces. The predominant Japanese artillery piece was the 75 mm gun, whereas, most of our artillery weapons were 105 mm or larger caliber. In relative lethal effects a sharp contrast is observed between the U.S.grenade, ~~26.5~~ per cent, and the Japanese grenade, 4.4 per cent. This finding is in accord with the generally observed ineffectiveness of the Japanese grenade.

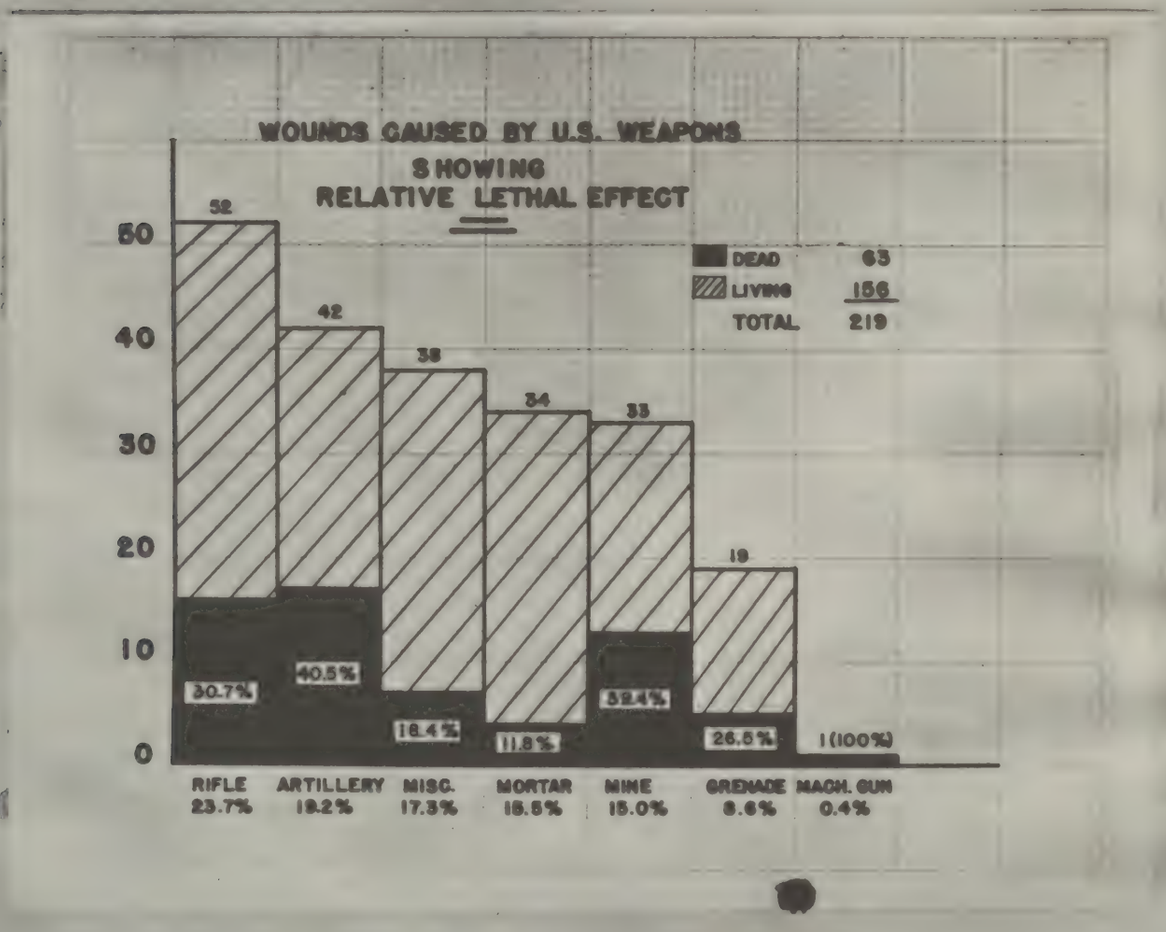
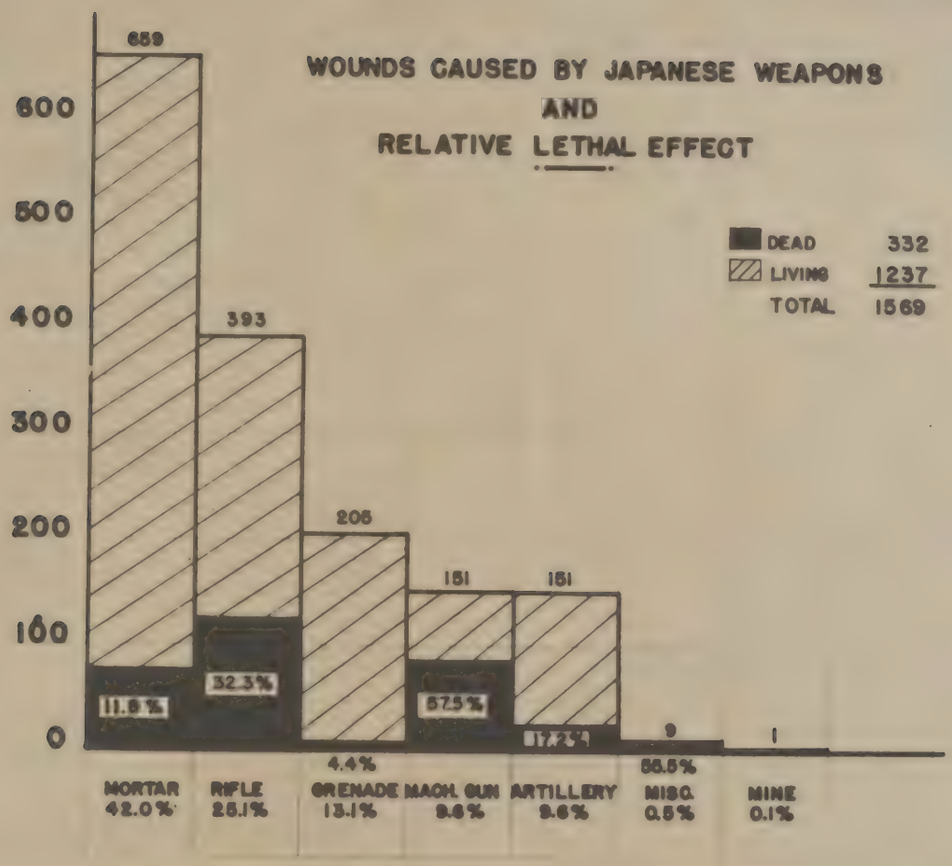


Fig.75


WOUNDS CAUSED BY JAPANESE WEAPONS
AND
RELATIVE LETHAL EFFECT
DEAD 332
LIVING 1237
TOTAL 1569
659
393
205
151
151
9
1
600
500
400
300
200
100
0
11.6%
32.3%
57.5%
4.4%
55.5%
MORTAR 42.0%
RIFLE 25.1%
GRENADE 13.1%
MACH. GUN 9.6%
ARTILLERY 9.6%
MISC. 0.5%
MINE 0.1%

6. TREATMENT OF THE WOUNDED

A detailed clinical study would be out of place in a report on Wound Ballistics. On the other hand a resume of end results in the treated wounded is essential to the proper evaluation of the effect of weapons. This is well illustrated by the results obtained in the treatment of compound fractures of the femur early in World War I, when the mortality at first was 50 per cent. Such a mortality would materially change the evaluation of the effect of weapons causing wounds in the lower extremities

The purpose of this report on the treatment of the wounded is to indicate the quality of the treatment, good or bad; to account for all of those wounded in action and who died later; to record the amount of disability as indicated by the disposition of the patients and to give a very brief classification of the types of wounds encountered in the various anatomical regions. A recording of the circumstances as to how each wound was acquired and even a brief description of the wound would make this report far too lengthy. On the other hand such descriptions are helpful in giving the reader an appreciation of the type of warfare encountered. For this reason a brief description is given of the circumstances associated with the wounding of each patient who was wounded in action and died later.

a. Wounds of the Head and Neck

There were 250 patients with wounds of the head and neck alone who were seen alive*. Ten of this number 4 per cent) died. These ten patients were considered as mortally wounded and seven died without operation (Cases 1 to 7). Three patients died following operation making an operative mortality for all head and neck wounds of 1.2 per cent. (Cases 8, 9 and 10).

Of these 250 patients, 198 had wounds of the scalp, face and neck. Only one patient died (Case 5) giving an operative mortality of 0.5 per cent. There were fifty five patients who had injuries of the eye, nineteen of whom (35.5 per cent) were returned to the United States, because of permanent visual impairment. The most serious wounds encountered in the group of face and neck injuries were four perforations of the trachea, nine compound fractures of the mandible, and four of the maxilla. The majority of face and neck wounds were not serious, and 86.6 per cent of the patients who received such wounds were returned to duty within four months. There were fifty two patients who sustained brain injury. Twenty seven of these had concussion and three were evacuated to the United States.

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* There were ninety patients listed under multiple wounds who had [illegible] wounds of the head and neck. However, these wounds did not constitute major problems of the head and neck, and [illegible] classification, such patients were classified only under multiple wounds.

Of the remaining twenty five patients who had brain injury, nine were mortally wounded. Nineteen of these patients underwent operation and three died, making a mortality of 15.7 per cent. All three of these patients may be considered as having been mortally wounded (Cases 8, 9, and 10). Among the nineteen cases having operation, the dura was open and the brain lacerated in fourteen, and in five there were depressed fractures without opening of the dura.

(Wounded in Action and Died Later)

Case 1. [redacted], Pvt (Fijian), while on patrol was wounded by a fragment of a U.S. 90 mm shell which exploded at 20 yards distance at 1700 hours, 30 March 1944. At the 21st Evacuation Hospital he was found to have a penetrating wound of the skull thru the right frontal bone with extensive laceration of the brain and severe intracranial hemorrhage. He died shortly after arrival at 2000 hours, 30 March 1944, of respiratory failure and extensive brain damage. (See autopsy protocols Case 3.)

Case 2. [redacted], Pvt (Fijian), while on patrol was struck by a U.S. 90 mm shell fragment 25 yards from the burst at 1700 hours, 30 March 1944. He received a penetrating wound of the head in the right temporal region and was taken directly to the 21st Evacuation Hospital. The patient was in extremis and died at 1855 hours, 30 March 1944 (See autopsy protocols Case 12).

Case 3. [redacted], 145th Inf., 37th Division, was struck in the head by a Japanese machine gun bullet fired from a distance of 30 yards at 1250 hours, 9 March 1944. He was given first aid including plasma, but never regained consciousness and died in the battalion aid station 2 hours later.

Case 4. [redacted], 1st Lt., (Fijian) was mistaken for the enemy and shot in the head and abdomen by a U.S. .303 caliber rifle at a distance of 15 yards. He was wounded at 1810 hours, 23 March 1944, and taken directly to the 21st Evacuation Hospital. There a severe gutter wound of the right side of the head with extensive brain damage and a wound of the abdomen were disclosed. He was given 1 unit of plasma, but being in extremis died at 2055 hours, 23 March 1944. (See autopsy protocol Case 22).

Case 5. [redacted], 182nd Inf., while withdrawing from enemy fire was hit in the back of the neck by a .25 caliber Japanese bullet fired by a sniper from a distance of 35 yards. He was wounded at 0600 hours, 15 March 1944, kept in the battalion aid station about 2 hours, and then taken to the 21st Evacuation Hospital. He was paralyzed and in shock and no operation was done. His death was associated with hyperthermia and occurred at 1300 hours, 15 March 1944. The clinical impression was transection of the cervical cord at C-5, but postmortem revealed that the cord

had not been penetrated. (See autopsy protocol Case 21). Note: This was the only instance of trauma to the spinal cord in which the dura was intact.

Case 6. [redacted], 145th Inf., 37th Division, was struck by fragments of a mortar shell which exploded in a tree 15 feet overhead. He sustained multiple wounds of the head and shoulder and a partial avulsion of the leg. A tourniquet was applied to the leg plasma given and the patient was removed from the lines within an hour. He died on the way to the hospital. Death was thought to have been due to head injury.

Case 7. [redacted], 129th Inf., 37th Division, was wounded by a .25 caliber bullet fired by a Japanese sniper from a distance of 75 yards. The bullet passed thru the helmet producing a severe gutter wound of the right parieto-occipital region. The injury occurred at 1430 hours, 24 March 1944. The patient received aid promptly and was given 9 units of plasma before arriving at the 21st Evacuation Hospital. He was mortally wounded, however, and died at 1920 hours, 24 March 1944, without operation. (See autopsy protocol Case 25).

Case 8. [redacted], 145th Inf., 37th Division, was struck by a Japanese machine gun bullet fired from a distance of 30 yards on hill 700. Because the road was under enemy fire, a 1000 yard litter carry was necessary over very rough terrain. He was given plasma at the aid station but arrived at the hospital in a semiconscious condition. He had a gutter wound of the left fronto-temporal region and a severe laceration of the brain. The wound was debrided and shock treated, but the patient died 24 hours later. Death was due to extensive brain damage.

Case 9. [redacted], 129th Inf., 37th Division, was struck by a fragment of a Japanese mortar shell (90 mm) which burst 20 feet distant at 0630 hours, 17 March 1944. The shell fragments destroyed one corner of the pillbox, killed one soldier and wounded Shervinsky. He was removed to the aid station at 0830 hours, and thence to the 21st Evacuation Hospital. He had a gutter wound of the right temporal region which measured 4 x 2 inches and a deep laceration of the brain measuring 2 x 2 x 2 inches. While the patient appeared to be mortally wounded, a sanguine attempt was made to control hemorrhage. In spite of supportive treatment, the patient died at 2000 hours, 17 March 1944 with hyperthermia. (See autopsy protocol Case 26).

Case 10. [redacted], 145th Inf., 37th Division, was struck by a fragment of a Japanese mortar shell which burst 3 yards distant at 1800 hours, 10 March 1944. He was evacuated promptly to the 21st Evacuation Hospital and found to have a severe wound penetrating the right eye and base of the skull with intracranial hemorrhage. In spite of supportive treatment he died at 2400 hours, 10 March 1944. (See autopsy protocol Case 23.)

b. Wounds of the Thorax

A discussion of wounds of the thorax is complicated by the fact that oftimes these missiles pass thru the diaphragm causing wounds of abdominal organs which in turn may be responsible for the death of the patient. For this reason wounds involving both the thorax and abdomen are discussed in a separate section. Multiple wounds present a special problem, since they include many wounds of the thorax and they also are discussed in a separate section. Included under multiple wounds were sixty two wounds of the thoracic wall alone and three wounds perforating the lung. None of these patients died and the three perforating wounds were treated conservatively.

Excluding the groups previously mentioned, there were 156 patients with wounds of the thorax who were seen alive. Thirteen of these patients died giving a mortality of 8.3 per cent; the operative mortality for the entire group, however, was much lower since seven of these patients died of shock and hemorrhage without operation (Cases 1 to 7).

Wounds of the thorax may be divided into two general groups, those involving the chest wall only and those perforating the thoracic cage. There were 102 patients (65.4 per cent) who had wounds limited to the thoracic wall. None of these patients died. The majority of these had penetrating wounds caused by small fragments from high explosive shells. Only ten of these patients (9.8 per cent) were evacuated to the United States, and the remainder returned to duty.

There were fifty four patients with perforating or lacerating wounds of the lung who were seen alive. All of the thirteen deaths occurred in this group, making a mortality of 24.1 per cent. Eighteen of these patients were known to have had sucking wounds. There were twenty nine open operations on the chest with six deaths, an operative mortality of 20.7 per cent. (Cases 8 to 13). Eighteen patients with penetrating or perforating wounds were treated conservatively with debridement only. There were no deaths in this group. The total operative mortality for perforating or lacerating wounds of the lung was 12.7 per cent, forty seven patients underwent operation and six died.

(Wounded in Action and Died Later)

Case 1. [redacted], Service Btry., 246th F.A.Bn., Americal Division, was riding in the back of an uncovered truck when a Japanese 105 mm shell exploded at a distance of 5 yards to the rear at 0730 hours 8 March 1944. He was struck by a shell fragment which caused a large wound of the left posterior chest. He was taken immediately to a battalion aid station, a dressing applied and plasma given. He did not recover from shock, however, and died at 1120 hours, 8 March 1944.

Case 2. [redacted], 145th Infantry, 37th Division, was lying prone on the ground when a mortar shell exploded at a distance of 2 feet at 0800 hours, 12 March 1944. On arrival at the 21st Evacuation Hospital 50 minutes later, he was in extremis with multiple wounds of the left jaw, upper right arm, and profuse hemorrhage from a large perforating wound which extended thru the right shoulder into the chest cavity. He was mortally wounded and died without treatment at the hospital at 0910 hours, 12 March 1944.

Case 3. [redacted], 182nd Infantry, Americal Division, was manning a machine gun in a foxhole on Hill 260. 3 others had been wounded in this same position by a heavy barrage of Japanese knee mortar shells. This soldier slipped out to look for the enemy position and was struck by a fragment of a Japanese mortar shell which burst at a distance of 40 yards. He received multiple severe wounds of the left chest and arm, and did not regain consciousness. He died from hemorrhage in the battalion aid station at 1300 hours 11 March 1944.

Case 4. [redacted], 182nd Infantry, Americal Division, was advancing in an upright position in a skirmish line on Hill 260 when struck by Japanese .25 caliber machine gun bullets at 1430 hours, 10 March 1944. He received multiple wounds of the chest and arm, was given first aid which included plasma but died at the Collecting Company at 1530 hours, 10 March 1944.

Case 5. [redacted], 145th Infantry, 37th Division, was standing in a covered foxhole by a machine gun when hit by a Japanese mortar fragment at a distance of 5 yards from the burst. 3 others in the foxhole were uninjured. The shell fragment penetrated the left shoulder and entered the chest. He received immediate first aid including plasma at the aid station. The wounding occurred at 0545, 12 March 1944 and the patient died in the aid station of pulmonary hemorrhage 3 hours later.

Case 6. [redacted], 129th Infantry, 37th Division, was advancing behind a tank when wounded by a Japanese .25 caliber machine gun bullet fired from a distance of 25 yards at 1245 hours, 24 March 1944. The bullet entered the chest and transected the spinal cord. His death at the 21st Evacuation Hospital 24 hours later was accompanied by shock and hyperthermia. (See autopsy protocol No.52).

Case 7. [redacted], 132nd Infantry, Americal Division, was wounded by a shell fragment from a U.S.artillery "short" at 0815 hours, 7 April 1944. The distance from the burst was unknown. A large sucking wound of the left chest and multiple penetrating wounds of the left thigh were evident. He died in the clearing station at 1145 hours, 7 April 1944, as a result of severe hemorrhage from the chest wound.

Case 8. [redacted], Pfc (Fijian), was crouching on patrol when struck by a .25 caliber Japanese sniper bullet fired from a distance of 15 yards. An extensive wound of the left lower chest was accompanied by profuse hemorrhage. On arrival at the 21st Evacuation Hospital it was evident that fatal exsanguination was imminent, accordingly an immediate but futile attempt was made to relieve intrathoracic pressure and to control hemorrhage. During operation the patient was given 1500 cc of whole blood and 6 units of plasma, but he died on the operating table. Postmortem examination revealed a dilated heart. It was the opinion of the surgeon that in the presence of pulmonary damage occasioned by the wound plus manipulation of the lung, the rapid administration of large volumes of blood and plasma may have resulted in overloading the pulmonary circulation and thus produced dilation of the right heart. (See autopsy protocol No.56).

Case 9. [redacted], 182nd Infantry, Americal Division, was lying prone on Hill 260 operating a machine gun when hit by a .25 caliber Japanese machine gun bullet fired from a distance of 50 yards at 1200 hours, 12 March 1944. He sustained a sucking wound of the lower right chest accompanied by multiple fractured ribs posteriorly and disruption of the rib cartileges anteriorly. At the 31st Portable Surgical Hospital 2000 cc of plasma and 1200 cc of whole blood were administered and the skin rapidly closed over the sucking wound. After transfer to the 21st Evacuation Hospital the patient continued to have severe respiratory difficulty because of the crushing chest wound. An attempt was made to reconstruct the posterior thoracic cage by wiring the 4th, 5th, 6th, 7th, and 8th ribs to their paravertebral stumps. At operation the lung was stated to have the appearance of "blast injury" (consolidation). There were several rents in the lung but no bleeding. On 14 March 1944 it was apparent that the patient had pneumonia, his temperature had risen to 106 degrees F. and his respiratory rate to 50. Accordingly 100,000 units of penicillin were given. The paradoxical breathing due to the disrupted anterior cartileges became worse and the patient died of respiratory failure at 2300 hours, 14 March 1944.

Case 10. [redacted], 129th Infantry, 37th Division, was prone on the crest of a ridge behind a tank attack when hit by a .25 caliber Japanese rifle bullet fired from a distance of 100 yards. He received a severe wound of the left posterior thorax at 1100 hours, 24 March 1944, and was removed at once to the 21st Evacuation Hospital. At operation the lacerated lung was repaired and the wound closed tightly. On the following day, because of the development of pneumonia, penicillin therapy was instituted using 25,000 units every four hours. A severe right pneumothorax was aspirated. On 26 March the patient's temperature was 105 and his condition poor. Slight improvement occurred, but on 28 March the patient suddenly cried out, ceased breathing, and died at 0730 hours. The radial pulse was perceptible for a brief interval after respiration ceased. A diagnosis of pulmonary embolism was made. (See autopsy protocol Case No.50).

Case 11. [redacted], Commirsols, 13th AAF, accidentally shot himself with a .30 caliber carbine at 0100, 4 April 1944. The bullet perforated the left chest. He was taken immediately to the 52nd Field Hospital and given 3 units of plasma. At operation 2 hours later, the patient died on the table. The cause of death was not entirely clear, although a large intrapleural hemorrhage may have been sufficient to account for the fatal termination. A contusion of the heart muscle was found at postmortem. (See autopsy protocol Case No.53).

Case 12. [redacted], 129th Infantry, 37th Division, was standing by his foxhole when struck by a fragment of a 4.2 U.S.mortar shell which fell short and burst at a distance of 7 feet. At the 33rd Portable Surgical Hospital a sucking wound of the right chest was sutured. Since this hospital had no thoracic surgeon, the patient was transferred to the 21st Evacuation Hospital. Enroute, severe bleeding was initiated by dehiscence of the recently sutured thoracic wound. While 1500 cc of blood and 10 units of plasma were being administered a second operation was done. A rib fragment was removed from the lung and active bleeding of the intercostal arteries controlled. The wound was closed tightly with thru and thru sutures. At the termination of the operation the blood pressure was 80/50. A penicillin solution containing 17,500 units was left in the pleural cavity. The patient did not recover consciousness and died at 1500 hours, 30 March 1944. Autopsy showed acute dilatation of the heart, blast injury of the right lung and hemorrhage in the right pleural cavity. (Note: Interhospital transfer of this patient was obviously inadvisable).

Case 13. [redacted] 162nd Infantry, Americal Division, was moving up a hill when struck by a .25 caliber Japanese bullet fired from a distance of 30 yards, at 1130 hours, 20 March 1944. The bullet fractured the posterior 9th rib, perforated the upper lobe of the right lung and made its exit in the right supraclavicular fossa. Sucking wounds were present on the posterior and anterior aspects of the chest, with free bleeding from the posterior wound. At the 31st Portable Surgical Hospital plasma was given and the sucking wounds were debrided and closed. The lung appeared consolidated from intrapulmonary hemorrhage. The patient died of shock and hemorrhage shortly after operation.

c. Wounds of Thorax and Abdomen

The anatomical divisions of thorax and abdomen are satisfactory for a consideration of wounds of entrance. However, from a clinical standpoint, those wounds which are caused by missiles which pass from one cavity into the other present special problems of sufficient importance to warrant placing them in a separate category.

There were twenty four patients with wounds in which the missile penetrated both the thoracic and abdominal cavities. More than half of these wounds were caused by bullets entering the chest. The various missiles entered thru

the thorax in seventeen cases, through the abdomen in four, and through both the abdomen and chest in three. Bullets caused sixteen of these wounds, mortar fragments five, and artillery shell fragments three.

The mortality of these wounds is higher than for wounds of the thorax or abdomen alone. Of the twenty four cases, eighteen died resulting in a mortality of 75.0 per cent. Three of these patients died of hemorrhage and shock without operation. Twenty one patients underwent operation. Of these, fifteen died, giving an operative mortality of 71.4 per cent. Brief case histories are given for all patients who were wounded in action and died later.

The high operative mortality requires this further explanation. If medical installations had not been so easily available some of these patients probably would have been classed as killed in action. Shock from hemorrhage was usually severe and occasionally when bleeding continued it was necessary to attempt "heroic surgery" (Case 5) in an effort to control it. Bleeding into both the thorax and abdomen resulting from explosive wounds of the liver, spleen, and kidney frequently contributed to the shock. On the whole anesthesia appeared to have been well done but occasionally left something to be desired. More whole blood would have been beneficial in some instances, since blood loss was frequently great and could be replaced by plasma only within limits. Hemorrhage and shock were the chief causes of death as seen in Cases 5, 6, 8, 10, 11, 14, 16, 17, and 18. Case 15 was moved immediately after operation. This may have contributed to the chock. Case 4 illustrates the sequelae which may be encountered from the blast effect due to high velocity bullets. Case 12 died with uremia associated with a high sulfathiazole blood level. (This patient also had an explosive wound of one kidney.) Extensive liver damage appeared to account for 1 death, Case 7. Two patients who were evacuated to the rear echelon died; one from sepsis and empyema (Case 9), and the other from secondary hemorrhage (Case 13). The strain of evacuation may have contributed to death in these cases.

(Wounded in Action and Died Later)

Case 1. [redacted], 132nd Infantry, Americal Division, was running between foxholes on Hill 260 when shot by a .25 caliber rifle at 40 yards. The bullet entered the thorax at the level of the left 7th rib in the anterior axillary line. He was wounded at 1530 hours, 14 March 1944. Within 15 minutes after receiving first aid he was taken to the aid station and from there transferred directly to the 31st Portable Surgical Hospital. The wound was extensive as the bullet had passed tangentially from the thorax into the abdomen, and had lacerated the left lung, perforated the diaphragm and had produced a massive hemothorax. The spleen was shattered, gastrosplenic artery and renal vein divided and "entire descending colon avulsed". Because he was mortally wounded the patient was given supportive treatment only. He died at 0515 hours, 15 March 1944.

Case 2. [redacted], 3rd Bn., 145th Infantry, 37th Division, was souvenir hunting when hit by a .25 caliber Japanese rifle bullet fired from a distance of 70 yards. He was in severe shock when first seen at 1420 hours, 12 March 1944. At the aid station he was given 3 units of plasma and then transferred to the clearing station. The bullet had entered the left posterior chest and had produced a large wound of exit in the left upper quadrant of the abdomen from which omentum protruded. He did not respond to therapy and died in the shock tent at 1700 hours, 12 March 1944.

Case 3. [redacted], 82nd Chemical Bn., 37th Division, was standing in a pit beside his mortar when a Japanese 7.7 mm mortar shell exploded 4 yards distant at 1930 hours, 8 March 1944. He was taken directly to the 21st Evacuation Hospital and on arrival was found to be in profound shock from multiple wounds of the thorax and abdomen and both lower extremities. A severe compound fracture of the left femur was present. He did not respond to shock therapy and died without operation at 0530 hours, 9 March 1944. Death resulted from hemorrhage, shock, and respiratory failure. Cursory postmortem examination revealed multiple penetrating wounds of left chest and abdomen involving the large bowel.

Case 4. [redacted], 129th Infantry, 37th Division, was prone on the ground in front of the tanks when shot by a .30 caliber Japanese machine gun at 35 yards distance. He was struck by 2 bullets in the back at 0830 hours, and taken directly to the 21st Evacuation Hospital. He had an obvious left hemothorax, a sucking wound of the chest and questionable abdominal involvement. After preliminary shock treatment the explosive wound of the chest was debrided and closed. The abdomen was then opened, but no lesion was found. He responded well to operation, but developed increasing respiratory difficulty (blast effect) requiring frequent aspiration and died at 0645 hours, 28 March 1944. (See autopsy protocol Case 54).

Case 5. [redacted], 3rd Bn., 145th Infantry, 37th Division, was among a group of men preparing to climb into a truck when 4 shells struck within a radius of 15 yards at 0730 hours, 18 March 1944. 12 men were killed. Lawson received first aid immediately and arrived at the 21st Evacuation Hospital within an hour. He had a large sucking wound of the posterior chest with a laceration of the left lower lobe of the lung, perforation of the diaphragm, and laceration of the spleen and cardia of the stomach. He received 2000 cc of blood and 8 units of plasma within 6 hours, but neither regained consciousness nor recovered from shock. Thoractomy was necessitated because of continued intrathoracic bleeding which produced a shift of the mediastinum. At operation 3000 cc of blood were removed from the pleural cavity and lacerations in the lung and dome of the diaphragm were repaired. In spite of continuous shock therapy recovery was not sufficient to allow repair of the abdominal defects. He died at 0545 hours, 19 March 1944. (See autopsy protocol Case 74).

Case 6. [redacted], 24th Infantry, 93rd Division, was on a combat patrol prone on the ground when shot by a .30 caliber Japanese machine gun, distance unknown. He received multiple wounds at 1000 hours, 19 April 1944, was given first aid and arrived at the 52nd Field Hospital at 1400 hours. In order to combat severe shock he was given 1000 cc blood and 1250 cc of plasma. Because of suspected lung hemorrhage, thoracotomy was performed. A bone fragment was removed from the lung and the pleura and diaphragm were sutured. He did not respond to shock therapy and died at 2125 hours, 19 April 1944. (See autopsy protocol No.73 for description of multiple wounds).

Case 7. [redacted], 145th Infantry, 37th Division, was climbing a hill when hit by a .25 caliber Japanese sniper bullet fired from a distance of 30 yards. He was wounded at 1745 hours, 11 March 1944, given first aid, and taken directly to the 21st Evacuation Hospital. After adequate shock therapy thoracotomy was performed. The lower lobe of the right lung was lacerated and showed consolidation (blast), the 8th and 9th ribs were shattered, and in addition a rent in the diaphragm and a severe explosive wound of the liver were discovered. The lung was sutured, the diaphragm transplanted and the liver packed. Death occurred at 1600 hours, 15 March 1944, prior to which time recovery had seemed satisfactory. Post-mortem examination showed no cause of death other than extensive liver damage.

Case 8. [redacted], 57th Engr, Americal Division, was accidentally shot by a .30 caliber M1 rifle at 1300 hours, 22 February 1944 at 1 foot distance. After receiving immediate first aid and plasma he was taken to the 52nd Field Hospital. A large sucking wound of the right chest was present. Because of continued hemorrhage plasma and 1000 cc of blood were administered during operation. Thoracotomy revealed a perforation of the diaphragm, an explosive wound of the liver and large hemothorax. An attempt was made to control bleeding from the liver by packing it with muscle. The patient died of shock and hemorrhage one half hour after the conclusion of the operation at 1615 hours, 22 February 1944.

Case 9. [redacted], 145th Infantry, 37th Division was kneeling, when shot by a .30 caliber Japanese rifle at 40 feet on 16 March 1944. A sucking wound of the right lower chest resulted. After blood and plasma transfusions the thorax was explored at the 21st Evacuation Hospital. It was found that the bullet had perforated the lower lobe of the left lung, guttered a large wound in the diaphragm, and transected the spinal cord at the level of the 12th dorsal vertebra. A right lower lobectomy was done and the diaphragm repaired. He was evacuated to the rear echelon in good condition on the 8th post-operative day. Later he developed empyema and in spite of adequate drainage and penicillin therapy, died on 25 April 1944. (See autopsy protocol No.55).

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Case 10. [redacted], 3rd Bn., FIR (Filipino) was mistaken for the enemy and shot by a .30 caliber machine gun at 30 yards distance. He was wounded at 1500 hours 1 April 1944, and was evacuated immediately to the 21st Evacuation Hospital. After shock treatment, thoracotomy was done because of suspected hemorrhage. At operation a right lower lobectomy was performed and an extensive wound in the liver packed. He did not recover from this operation, and died at 2030 hours, 1 April 1944. (See autopsy protocol No.72.)

Case 11. [redacted] 37th Div. Tr., 37th Division, was on a combat patrol which was ambushed. He was shot by a .25 caliber Japanese rifle at 25 yards distance, at 1615 hours, 4 March 1944. He received first aid treatment but did not arrive at the hospital until 0800 hours, 5 March 1944. The bullet entered the abdomen through the left flank and made its exit through the right anterior chest wall. After shock therapy perforations of the small and large bowel were sutured. The patient did not recover from shock and died at 1615 hours, 5 March 1944. (See autopsy protocol No.71).

Case 12. [redacted] 3rd Bn., 132nd Infantry, Americal Division, while on combat patrol was shot with a Japanese rifle as he entered an enemy pillbox, at 1700 hours, 29 March 1944. After a long carry he arrived at the 121st Clearing Station at 2000 hours, 30 March 1944. The bullet had entered the chest in the 8th interspace in the posterior axillary line and had perforated the diaphragm, large bowel and kidney. At operation a laceration of the diaphragm was repaired, the large bowel perforation sutured, a transverse colostomy performed, and sulfonamide therapy instituted. On the third day, the urinary output having decreased to 200 cc., a diagnosis of uremia was made. The sulfonamide level was then 24. After transfer to the 21st Evacuation Hospital he died at 0600 hours, 4 April 1944. (See autopsy protocol No.68).

Case 13. [redacted] 1st Bn., 129th Infantry, 37th Division, was shot through the arm and chest by a .25 caliber Japanese rifle bullet on 13 March 1944. After receiving plasma he was taken directly to the 21st Evacuation Hospital. The bullet had fractured the left humerus, penetrated the chest, perforated the diaphragm, and produced a hemothorax. The wound was debrided and the pleura closed. The patient was evacuated by air on 15 March 1944. He died on 21 March 1944 of secondary hemorrhage. (See autopsy protocol No.69).

Case 14. [redacted] 182nd Infantry, Americal Division, was in a foxhole on Hill 260, when hit by a .25 caliber Japanese machine gun bullet fired from a distance of 40 yards. He was wounded at 1200 hours, 11 March 1944. At the 31st Portable Surgical Hospital it was found that the bullet had entered the left chest in the 7th interspace posterior axillary line and had coursed downward and forward into the abdomen. A sucking wound of the chest was closed and the abdomen opened. The bullet had perforated the diaphragm, stomach, and liver, and had shattered the spleen. The various perforations were closed and

the spleen removed. The patient did not rally and died at 0700, 12 March 1944. Autopsy revealed that a perforation of the jejunum had been overlooked at operation. Death was attributed to peritonitis although shock was also a factor.

Case 15. [redacted], Co.B., 182nd Infantry, was advancing on a combat patrol when shot by a machine gun at close range on 8 March 1944. He continued to command for 20 minutes, but was then evacuated to the 31st Portable Surgical Hospital. The bullet had entered just medial to the anterior axillary line in the 5th interspace and made exit near the 12th rib posterior. In its course it had perforated the lung, diaphragm, stomach, and spleen. At operation the diaphragm and stomach were repaired. The patient was transferred to the 21st Evacuation Hospital on 9 March 1944, and died the following day at 1845 hours. (Note: The transfer of this patient on the first day after operation was inadvisable.)

Case 16. [redacted] 145th Infantry, 37th Division, was struck by a fragment of a Japanese knee mortar shell on Hill 700. He was approximately 25 yards from the burst. Having received plasma and immediate first aid dressings, he was taken to the 21st Evacuation Hospital. Because of multiple perforating wounds of the chest and abdomen, laparotomy was done. Extensive laceration of the liver and several perforations of the jejunum and duodenum were repaired. He died of shock and hemorrhage on the day of operation at 2240 hours, 11 March 1944.

Case 17. [redacted] 920th A.B.S., was riding on a truck when a Japanese artillery shell exploded 5 feet behind his vehicle at 0600 hours, 24 March 1944. He was taken directly to the 52nd Field Hospital and treated for shock. There were 2 wounds, one traversed the 4th and 5th ribs in the mid-axillary line, perforated the left lower lobe and entered the posterior mediastinum. The second fragment entered the left ilial region and perforated the sigmoid colon. Massive hemothorax was present. At operation the perforation of the lung was sutured and the sigmoid colon was exteriorized. The patient was given 4000 cc. of plasma and 1000 cc. of whole blood. He did not respond, however, and died eight hours after the operation. (See autopsy protocol No.57).

Case 18. [redacted] 1st Bn., FIR (Fijian), was crawling on a combat patrol, when a Japanese mortar shell exploded at a distance of 20 yards, on 29 March 1944. On arrival at the 21st Evacuation Hospital he received treatment for shock. Perforating wounds involved the lung, diaphragm, colon, spleen, pancreas, and left kidney, and the patient also had a fracture of the left humerus. The spleen was removed, the colon exteriorized and the diaphragm repaired. He died at 2215 hours, 30 March 1944. (See autopsy protocol No.70.)

d. Wounds of the Abdomen

This anatomical division is used to designate not only the abdominal cavity and contents but also the various structures surrounding it, including the muscles of the abdominal wall, the vertebral column and the ilia. Wounds involving both the thorax and abdomen are considered in a separate section.

There were eighty six patients who had wounds of the abdomen, in forty nine the wounds were limited to the abdominal wall and in thirty seven they penetrated the abdominal cavity. The majority of wounds limited to the abdominal wall were caused by high explosive missiles, chiefly mortar fragments. There were five deaths among the forty nine patients who received wounds of the abdominal wall only (Cases 1 and 2) died before operation. One death followed a negative abdominal exploration. (Case 18).

Penetration of the abdominal cavity was found in thirty seven patients. There were twelve deaths among thirty six patients undergoing operation making a total operative mortality of 33.3 per cent. It must be borne in mind, however, that this high operative mortality is accounted for in part by many mortally wounded patients who died of shock, on whom operation was undertaken with little hope of success (Cases 5, 7, 10, 11, 12, 13, 14). One patient died of shock before operation, (Case 3), two died of peritonitis (Cases 6, 8), and one of unexplained uremia (Case 17). No deaths occurred because of failure to explore the abdomen but in two patients (Cases 4, 9) death resulted from visceral perforations which were overlooked at operation. The very early evacuation of patients from the portable surgical hospitals undoubtedly contributed to shock and was the factor which may have precipitated death in a few instances. (See Cases 4, 5, 7, 17). It is also known that patients do not tolerate air transportation well soon after abdominal operations, this type of evacuation may have contributed to the death of one patient (Case 18).

The large bowel was perforated in fifteen patients among whom there were five deaths, making an operative mortality of 33.3 per cent (See cases 4, 5, 6, 7, 8). Among these fifteen patients, the colon alone was perforated in five, the colon and spleen in one, and the colon and small intestine in nine. Four of the five deaths occurred in this latter group. The small intestine alone was perforated in six patients, the liver in four, the stomach in one and the bladder in one. All of these patients recovered. In addition three patients recovered who had wounds perforating the abdominal cavity in which the injury was limited to the peritoneum and mesenteric vessels.

(Wounded in Action and Died Later)

Case 1. [redacted], 145th Infantry, 37th Division, having returned from patrol was preparing to get into a truck when 4 Japanese artillery shells landed within a radius of 15 yards. (At the same time there were 12 others killed and 37 wounded). He was wounded at 1930 hours 18 March 1944 and taken directly to the 21st Evacuation Hospital. Multiple wounds were present which included spinal cord injury and an extensive avulsion of the tissues of the lumbar region exposing the vertebrae, spinal canal and both kidneys. The patient was treated for shock but died without operation at 1300 hours 19 March 1944.

Case 2. [redacted], 145th Infantry, 37th Division, while crawling in attack on Hill 700 was hit by a Japanese machine gun bullet fired from a distance of 30 yards. He was wounded at 0700 hours 10 March 1944 and arrived at 21st Evacuation Hospital at 1500 hours on the same day. Extensive compound fractures involving the sacrum, fourth and fifth lumbar vertebrae and the ilium were found. There was apparently no intra-abdominal injury, nevertheless the patient failed to recover from profound shock and died at 2330 hours 11 March 1944.

Case 3. [redacted] 132nd Infantry, Americal Division, returning from patrol was shot with a .25 caliber Japanese machine gun at 1600 hours 6 April 1944. He received first aid and remained in the command post overnight. After receiving plasma he was evacuated to the clearing station. Multiple wounds involving the lower thorax, abdomen and sacrum were found. There was no response to shock therapy and death occurred 8 April 1944. Postmortem examination showed peritonitis, resulting from multiple perforations of the colon and terminal ileum, destruction of vertebrae L5 to S2 and retroperitoneal hemorrhage.

Case 4. [redacted] 132nd Infantry, Americal Division, while walking along a trail on Hill 260 was wounded by a 90 mm Japanese mortar shell burst 25 yards distant at 1530 hours 13 March 1944. After immediate first aid treatment he was taken to the 31st Portable Surgical Hospital. Multiple wounds were present involving the right knee, thigh, right chest and abdomen. A shell fragment entered the abdomen through the left flank, passed transversely and perforated the large and small bowel. At operation the ileum, colon and mesocolon were repaired. On 15 March 1944 the patient was transferred to the 21st Evacuation Hospital. After the administration of 1000 cc of blood and 4 units of plasma, a transverse colostomy was done under local anesthesia because of severe abdominal distention. The patient died at 1115 hours 16 March 1944. Postmortem examination revealed peritonitis resulting from the two perforations of the jejunum which had been overlooked at operation. (See autopsy protocol 83). (Note: Interhospital transfer was inadvisable in this case).

Case 5. [redacted] Cav.Rcn.Tr., 37th Division, was running along a road carrying a box of ammunition when struck by a .25 caliber bullet fired by a Japanese tree sniper from a distance of 75 yards. He was wounded in the abdomen at 0739 hours 10 March 1944, and transported immediately to the 33rd Portable Surgical Hospital. In preparation for laparotomy he was given 4 units of plasma. At operation resection of 18 inches of lower ileum with a side to side anastomosis was done and a transverse laceration of the sigmoid colon was sutured. On 11 March he was transferred to the 21st Evacuation Hospital and died there of shock at 0700 hours, 12 March 1944. (Note: It was inadvisable to have transferred this patient before recovery).

Case 6. [redacted] 82nd Chemical Bn., 37th Division, was standing in the gunpit of a mortar battery when struck by a fragment of a 77 mm Japanese mortar shell which burst at a distance of 10 yards. Following wounding at 1930 hours, 8 March 1944, he was removed immediately to the 21st Evacuation Hospital. Severe wounds of the left flank and abdomen involving the sigmoid colon and retroperitoneal tissues were found at operation. The sigmoid colon was exteriorized, but the patient died of peritonitis at 1700 hours 13 March 1944.

Case 7. [redacted], 25th Infantry, 93rd Division, was returning from a patrol when wounded by a hand grenade which exploded in his pocket at 1700 hours, 9 April 1944. At the 31st Portable Surgical Hospital, 5 penetrating wounds of the right side of the abdomen and a compound fracture of the right hand were discovered. Because of the presence of shock he received 8 units of plasma, 1000 cc of blood and 4000 cc of glucose solution. The wounds were debrided. 8 inches of jejunum were resected and 8 perforations of the jejunum were sutured. Perforations of the descending colon, sigmoid colon and cecum were also repaired and a transverse colostomy done. The patient was transferred to the 21st Evacuation Hospital on 10 April, 1944, and died at 2355 hours 11 April 1944. (See autopsy protocol No.85). (Note: It was inadvisable to have transferred this patient on the first postoperative day).

Case 8. [redacted] 2nd Bn., 129th Infantry, 37th Division, while operating a machine gun was hit by a .25 caliber Japanese sniper bullet, distance unknown, at 1130 hours 13 March 1944. He received first aid within twenty minutes, was evacuated from the line within 1 hour and arrived at the 21st Evacuation Hospital shortly thereafter. After appropriate measures to combat shock laparotomy was done. The bullet, coursing upward after entering the abdomen on the left side, had produced 2 perforations of the descending colon, severed the right middle colic artery, perforated the jejunum in 3 places and then made its exit through the right rectus muscle. The visceral perforations were closed, and after resection of 4 inches of jejunum a catheter was placed in the bowel for decompression.

After a few days severe abdominal distention developed and it became obvious that the enterostomy was unsatisfactory. He died at 1400 hours 20 March 1944. At autopsy it was found that the catheter had slipped out of the bowel, probably because the bowel had not been sutured to the abdominal wall. "Bile peritonitis" produced by leakage was stated to have caused death.

Case 9. [redacted], 82nd Chemical Battalion, while walking along a column of vehicles which were moving into new positions was shot without challenge with an M1 rifle at a distance of 10 feet. He received first aid dressings and plasma immediately, and 2 hours later was taken to the 21st Evacuation Hospital. A severe wound of the abdomen was present and the sigmoid colon was perforated in 3 places. A bladder wound having been overlooked at the first operation was discovered on the following day. A suprapubic cystomy was done at once and at the same operation the left external iliac artery was ligated because of a contused area which had weakened its wall. The patient did not rally, appeared to be in shock and died at 0344 hours 16 March 1944.

Case 10. [redacted], 145th Infantry, 37th Division, was carrying ammunition to a gun position when a Japanese knee mortar shell burst 10 yards away. He was wounded in the lumbar region at 1330 hours 10 March 1944 and immediately transported to the 21st Evacuation Hospital. The shell fragment had passed through the left kidney, spleen, transverse colon and jejunum. The operation consisted of splenectomy, exteriorization of the transverse colon lesion and resection of a 3 inch segment of jejunum. Because of the patient's poor condition nephrectomy was not done. He did not recover completely from shock and died on 14 March 1944.

Case 11. [redacted] 82nd Chemical Bn., 37th Division, while standing in a gun pit of a mortar battery was hit by a fragment of a 77 mm Japanese mortar shell which burst at 5 yards distance. He received his wounds at 1930 hours 8 March 1944, and was taken immediately to the 21st Evacuation Hospital. Following treatment for shock laparotomy was done. One shell fragment passing laterally had perforated the transverse colon in 3 places, lacerated the right lobe of the liver and made an exit wound 4 inches in diameter in the lateral abdominal wall. Present also was a compound fracture of the left ulna and a large wound of the right ankle. There were other smaller wounds of the legs, thighs, buttocks, back and face. At operation the wounds were debrided, the perforations of the transverse colon sutured, and the defect in the liver repaired. The patient did not recover from shock and died on the following day at 2330 hours 9 March 1944.

Case 12. [redacted], 132nd Infantry, Americal Division, while advancing on Hill 260 was struck by a fragment of a 90 mm Japanese mortar shell, distance unknown. He was wounded at 0900 hours, 13 March 1944, given immediate first aid and then transported directly to the 21st Evacuation Hospital. The left arm was avulsed, an extensive wound of the right leg was present and the great vessels of this extremity were severed. There were multiple wounds of the abdomen and the ileum was perforated. Because of severe shock, the perforations of the ileum only were sutured at the initial operation. On the following day because of an extension of gangrene of the leg, amputation was done. The patient died at 2112 hours 15 March 1944. Postmortem examination showed no leakage from the repaired bowel. In this case death was attributed to "traumatic shock" despite the fact that there had been adequate blood replacement. (The surgeon expressed the opinion that "the operation should have been postponed and the limb packed in ice.)

Case 13. [redacted] 24th Infantry, 37th Division, while on patrol was struck by a Japanese .25 caliber bullet fired from a distance of 25 yards. While being moved he was shot again by the same rifleman. This second wound resulted in evisceration. He was wounded at 1030 hours 16 March 1944 and taken directly to the 21st Evacuation Hospital. There he received 1000 cc of blood and 3 units of plasma. The first bullet entered 2 inches below the right costal margin, passed downward along the rectus muscle into the flank, then through the wing of the ileum and made its exit in the right buttocks. The bullet causing the evisceration entered 2 inches below the left costal margin, travelled downward, destroying the rectus muscle, perforated the jejunum and ileum and passed under the inginal ligament into the thigh. Moderate shock was present. At operation the eviscerated intestine was enclosed in a pack while the rents in the jejunum and ileum were resected. Profound shock developed from which the patient did not recover and he died at 1515 hours 16 March 1944.

Case 14. [redacted] 135th F.A., 37th Division, accompanied a party burying the Japanese dead in front of the 129th perimeter. He wandered away and was shot by a Japanese .25 caliber rifle at 1545 hours, 27 March 1944. He was taken immediately to the hospital. The bullet entering the lumbar region had shattered the 12th rib driving bone fragments into the kidney and had then passed through the right lobe of the liver, causing an extensive laceration. Following appropriate shock therapy the abdomen was explored and the liver packed. Due to the poor condition of the patient only the loose fragments of kidney were removed. He did not recover from shock and died at 1830 hours, 27 March 1944. (See autopsy protocol 81).

Case 15. [redacted], 140th F.A., 37th Division, while on patrol looking for the enemy who had infiltrated the lines, was shot by a .25 Japanese rifle at 10 yards distance. He was wounded at 1605 hours 14 March 1944, received immediate first aid and arrived at the hospital within an hour. A wound was present in the left axilla and the axillary vein was severed. The major lesions consisted of compound fractures of the femur and ileum with an extensive wound penetrating the right hip joint. Severe shock was present. The axillary vein was ligated. Because of the presence of abdominal symptoms laparotomy was done but no lesion found. During this operation the urinary bladder was explored and closed. Because of the poor condition of the patient only a simple debridement of the hip wound was done. The patient showed a severe toxic reaction, developed gas gangrene of the hip and died on the second post operative day, at 1450 hours, 16 March 1944. (See autopsy protocol 103).

Case 16. [redacted] 145th Infantry, 2nd Bn., 37th Division, while attacking on Hill 700 was shot by a Japanese machine gun at 30 yards. He was wounded at 1630 hours, 9 March 1944, and taken immediately to the battalion aid station. After he had received 3 units of plasma he was evacuated by half track because the road was under fire. At the hospital, in order to combat severe shock, he was given 12 units of plasma and 500 cc. of blood. The bullet had entered the right iliac crest and passing downward had shattered the entire right wing of the pelvis. Exploration of the abdomen through a McBurney incision was negative. The hip wound was debrided and packed. He failed to recover from shock and died at 2300 hours, 10 March 1944.

Case 17. [redacted] 129th Infantry, 37th Division, was standing by a foxhole when a 4.2 U.S.mortar shell fell short and burst 7 feet away, on 27 March 1944. He received treatment for shock at the 33rd Portable Surgical Hospital. One shell fragment produced a large wound over the region of the right iliac crest, it also fractured the fifth lumbar vertebra and shattered the lower pole of the right kidney. Another fragment caused a wound of the right shoulder and arm. Shock therapy was continued while the wounds were debrided. The development of severe abdominal distention necessitated ileostomy. On 31 March he was transferred to the 21st Evacuation Hospital and died there on 1 April 1944 with unexplained uremia. (See autopsy protocol 84).

Case 18. [redacted] 182nd Infantry, Americal Division, was standing in the open when a Japanese hand grenade burst 3 feet away. He was wounded at 1345 hours, 13 March 1944. After arrival at the 31st Portable Surgical Hospital examination disclosed many wounds over the left side of the trunk and extremities. Following transfer to the Clearing Station abdominal exploration was done with negative results. He was evacuated by

air on 18 March 1944. On arrival at the 137th Station Hospital on Guadalcanal on the same day, evisceration was discovered. A secondary wound closure was done but the patient developed peritonitis and died on 25 March 1944. (See autopsy protocol 82). (Note: Air evacuation might have caused evisceration although planes transporting casualties usually fly at low altitudes.)

e. Wounds of the Extremities

Wounds of the extremities are of great importance because of their frequency. Wounds of the upper and lower extremities together (excluding multiple wounds) account for 40.6 per cent of all casualties (Fig.47). As a surgical problem, these wounds are of major significance since they comprise more than half of all the living wounded (Fig.49).

Three hundred and twenty patients had wounds of the upper extremities only one of whom was killed in action. This patient had a traumatic amputation. There was not a single death in the 319 treated wounds of the upper extremities. Gas gangrene infection did not occur. In this group there were 119 compound fractures of which 44 were in the humerus, thirty three in the bones of the forearm and forty two in the bones of the hand. There were ten amputations, two through the humerus because of extensive destruction of tissue and impairment of blood supply, one traumatic amputation of the hand and seven of the fingers.

There were 401 patients with wounds of the lower extremity (not including multiple wounds) eight of whom died. One patient died of unexplained cause (Case 1), two died because of shock and hemorrhage (Cases 2 and 3), one died in the rear echelon of uremia associated with a probable "crush syndrome nephrosis" (Case 4), two who were not seen by a medical officer died of shock and hemorrhage following traumatic amputations of the feet (Cases 5 and 6), and two died because of gas gangrene (Cases 7 and 8). Therefore, the total mortality for the wounded who were seen alive was 2 per cent.

There were ninety compound fractures of the lower extremities distributed as follows; femur twenty three, bones of the leg fifty one, and bones of the feet sixteen. All fractures were treated with plaster. There were no deaths due directly to compound fracture (See Case 4). There were eighteen amputations of the lower extremity of which seven were "traumatic" and eleven "elective". Of the seven traumatic amputations three died (Cases 3, 5, and 6). Of the eleven elective amputations, eight were done because of extensive tissue destruction and blood vessel injury. The one death in this group occurred in the rear echelon (Case 4). The remaining three amputations were necessary because of gas gangrene infection, although in two of these patients impending circulatory gangrene was also present. One of this group died. (Case 8). All amputations were of the guillotine type.

(Wounded in Action and Died Later)

Case 1. [redacted] 132nd Infantry, 37th Division, was lying prone in open jungle when struck by a .25 caliber Japanese machine gun bullet fired from a distance of 30 yards at 1800 hours, 2 April 1944. He was taken immediately to the battalion aid station and found to have a severe perforating wound of the right knee joint. While receiving first aid treatment he became hysterical and died suddenly at 1900 hours, 2 April 1944. While some hemorrhage had occurred, he had not lost enough blood to cause severe shock. Death was unexplained.

Case 2. [redacted] 132nd Infantry, 37th Division, leaving the trail to the observation post to try a "short cut", tripped the wire of a U.S. land mine which exploded a few feet away. He was wounded at 0715 hours, 22 March 1944. Plasma and morphine were administered by a medical officer within 10 minutes and the patient was immediately evacuated. At the clearing station examination disclosed an extensive wound of the dorsal aspect of the left thigh. Because of severe hemorrhage from the larger vessels 3 blood transfusions were given. Following debridement of the wound and ligation of the profunda artery, the patient did not recover from shock and died at 1500 hours, 22 March 1944.

Case 3. [redacted], 129th Infantry, 37th Division, was firing a machine gun when a Japanese knee mortar shell burst between his legs. He was wounded at 1000 hours, 12 March 1944, and taken immediately to the 33rd Portable Surgical Hospital. A traumatic amputation at the upper third of the right femur was completed by guillotine amputation under sodium pentothol anesthesia, and several small wounds of the posterior aspect of the left leg were dressed. Following operation, during which he received 4 units of plasma, the patient was transferred immediately to the 21st Evacuation Hospital. On arrival there the systolic blood pressure could not be obtained. While awaiting blood transfusion he was given one unit of plasma, but died before this could be completed at 1450 hours, 12 March 1944. Cause of death was shock and hemorrhage. (Note: This patient should not have been transferred to another hospital).

Case 4. [redacted], 129th Infantry, 37th Division, was lying prone in the open when struck by a fragment of a Japanese knee mortar shell which burst nearby. He was wounded on 15 March 1944 and taken to the 21st Evacuation Hospital. He had a severe wound of the right leg involving the vessels and nerves and a compound fracture of the tibia. This wound was debrided. The next day because of destruction of the blood supply a guillotine amputation was done 2 inches proximal to the knee joint. He was evacuated to a station hospital in the rear echelon on 19 March 1944. On 23 March he developed anuria and died with uremia at 0845 hours, 25 March 1944. Post-mortem examination revealed nephroses which was thought to have been due to "crush syndrome". (See autopsy protocol 93).

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Case 5. [redacted] 132nd Infantry, 37th Division, while on a combat patrol lying in an open foxhole, sustained a direct hit by a Japanese knee mortar shell. He was wounded at 1800 hours, 4 April 1944, was taken to the command post, given 2 units of plasma and morphine, and kept there over night. He had a traumatic amputation of the right foot. On the following day an attempt was made to transport this soldier to the hospital but he died enroute while crossing a river coming into our lines at 1300 hours, 5 April 1944. The wound was not bleeding when inspected prior to the journey hence a tourniquet was not applied. However, during the long carry bleeding occurred and death was apparently due to shock from hemorrhage. This might have been prevented by the use of a tourniquet. (See autopsy protocol 93).

Case 6. [redacted] 182nd Infantry, Americal Division, was digging a foxhole on Hill 260 when struck in the back by a ricochet .25 caliber Japanese bullet fired from an unknown distance. He was wounded at 1800 hours, 11 March 1944 and received immediate first aid. "There was practically no bleeding when bandaged. It was dark. We put him on a litter and started down the hill". The patient complained of feeling cold and when the bottom of the hill was reached he was found dead. Profuse hemorrhage had occurred. The rough journey down the hill in the absence of a tourniquet had apparently dislodged a blood clot thus initiating a fatal hemorrhage.

Case 7. [redacted] 2nd Battalion, 182nd Infantry, Americal Division, was patrolling on Hill 260 a short distance beyond the perimeter when he tripped the wire of a U.S.grenade booby trap at 1200 hours, 28 March 1944. (These booby traps had been set previously and no one knew where they were). He threw himself on the ground but was struck in the left buttock by a fragment at a distance of 3 yards from the burst. He was evacuated immediately to the clearing station and found to have a penetrating wound of the buttocks extending upward 7 inches into the soft tissues of the lumbar region. The point of entrance was 1 inch in diameter. Through a 3 inch incision the fragment was removed and the wound closed without drainage. The wound of entrance was debrided but not sutured. The tract was not debrided, but the wound was irrigated and dusted with sulfanilamide powder. After transfer to the 21st Evacuation Hospital on 3 March 1944, a diagnosis of gas gangrene was made. Despite the administration of 20,000 units of gas gangrene anti-toxin and 1000 cc. of blood, death occurred 4 hours later as a result of the very virulent clostridium Welchii infection.

Case 8. [redacted], 37th Cab Recon Trp., 37th Division, was near Hill 700 prone behind a tree when a Japanese knee mortar shell burst within a few feet. He was wounded at 0430 hours, 11 March 1944, and taken immediately to the battalion aid station. After receiving plasma he was transferred directly to the 21st Evacuation Hospital. He had multiple severe wounds of both legs, thighs, buttocks, scrotum, and back. Following the administration of an additional 3 units of plasma and 1000 cc. of blood, wound debridement was done under ether anesthesia. On 13 March 1944 he developed signs of gas gangrene of the right leg and was given 60,000 units of gas gangrene anti-toxin. On 14 March a guillotine amputation of the lower third of the thigh was done following which the patient became rapidly more toxic and died at 1415 hours, 15 March 1944.

[redacted]

f. Multiple Wounds

Only those patients who had two or more wounds in different anatomical regions either one of which might have produced death or disability are included in the classification "Multiple Wounds". When a single wound was considered responsible for the disability, even though several additional minor wounds were present, that patient was classified according to the anatomical location of the major wound. Many factors are involved when multiple wounds occur simultaneously in different parts of the body. For this reason endeavor was made to limit to a minimum the number of casualties included under the division designated "Multiple Wounds". Nevertheless, despite this effort there were 239 patients seen alive who were so classified.

In this group of 239 patients who received multiple wounds there were eight deaths, making a mortality of 3.3 per cent. With one exception (Case 3), those who died underwent surgical operation. These operations were usually sanguine procedures, and in most instances death resulted from shock and hemorrhage (Cases 1, 2, 4, 5, 6, 7). In one patient (Case 8) death was caused by gas gangrene infection.

In these 239 patients, 569 anatomical regions were hit with wounds distributed as follows: Upper extremity 202, (35.5 per cent); lower extremity 181 (32.0 per cent); head 92 (16.1 per cent); thorax 69 (12.2 per cent); and abdomen 25, (4.4 per cent). The number of wounds was actually in excess of these figures because several wounds frequently occurred in one anatomical region. There were 2.8 anatomical regions wounded per patient or well in excess of three wounds per patient, since many minor wounds from small fragments were not even tabulated.

(Wounded in Action and Died Later)

Case 1. [redacted], Americal Division, was struck by a fragment of a shell which burst near him in the mess hall, at 0730 hours, 11 March 1944. He reached the operating room of the clearing station within 15 minutes and although shock did not appear to be severe, was given 2 units of plasma. He had sustained a large perforating wound of the left leg, a compound fracture of the bones of the left foot, a wound of the left forearm, a severed temporal artery, and many small penetrating wounds. Following wound debridement shock supervened, and despite the administration of 1500 cc of blood and 2 units of plasma, the patient died at 1450 hours, 11 March 1944. Death was attributed to irreversible shock, although brain injury may have been a factor since bleeding from the ears was present.

Case 2. [redacted] 246th Field Artillery, was riding in the back of a truck when a Japanese 105 mm shell burst 5 yards to the rear at 0730 hours, 8 March 1944. (Three others were wounded). Because

[redacted]

hemorrhage was profuse, a tourniquet was applied to the leg immediately and plasma administered. At the nearby 36th Naval Hospital shock was evident associated with a severe wound of the left thigh and right forearm, and an extensive wound of the back accompanied by compound fractures of the third and fourth lumbar vertebrae. The wounds were cleaned but the patient did not recover from shock and died at 0120 hours, 9 March 1944.

Case 3. [redacted], Engr.Bn., 14th Corps, leaving his foxhole to rescue a friend was struck by fragments of a Japanese 90 mm mortar shell which burst 6 feet away at 0500 hours, 24 March 1944. He was taken directly to the hospital. It was apparent that the patient was mortally wounded, a blood pressure reading could not be obtained and profound shock was present. A severe wound involving the brain was found in the temporal region and a penetrating abdominal wound in the region of the right flank. He died without operation at 0830 hours, 24 March 1944. At postmortem extensive lacerations of the liver and kidney were discovered. (See autopsy protocol 99).

Case 4. [redacted], 132nd Infantry, Americal Division, was investigating a mine field when an M3 anti-personnel mine exploded within a few feet at 0830 hours, 27 March 1944. He received immediate first aid including 3 units of plasma, following which he was removed to the clearing station. A traumatic amputation of the left foot and extensive lacerated wounds of both buttocks and the right forearm were found. Operation under ether anesthesia was started at 1000 hours and completed at 1115 hours. During the operation 500 cc of blood and 1 unit of plasma were given, but at the conclusion of the procedure the blood pressure was only 90/60. While recovering from ether the patient struggled violently and died suddenly at 1455 hours, 27 March 1944. (See autopsy protocol 104).

Case 5. [redacted], 148th Infantry, 37th Division, was running across a jungle trail when a U.S. 81 mm mortar shell fell short and burst "right between his legs". He was wounded at 0945 hours, 1 April 1944, and was taken directly to the 33rd Portable Surgical Hospital. A traumatic amputation of the right foot, an incomplete traumatic amputation of the left leg and lacerated wounds of the right elbow and hand were evident. After the administration of 2000 cc of blood and 1 unit of plasma, the traumatic amputation of the left leg was completed at operation. The patient died on the operating table at 1500 hours, 1 April 1944. (See autopsy protocol 94).

Case 6. [redacted] 182nd Infantry, Americal Division, was in a slit trench covering a bazooka man in front when a Japanese knee mortar shell burst in the trench at 0830 hours, 11 March 1944. Both legs were blown off below the knees as well as the left arm and a portion of the right buttocks. He received 2 units of plasma, remained rational and reached the 31st Portable Surgical Hospital with comparatively little bleeding.

At operation the partial amputation of the arm was completed and the other wounds were debrided. He died at 1300 hours, 11 March 1944 of shock and hemorrhage.

Case 7. [redacted] 182nd Infantry, Americal Division, while in a foxhole on Hill 260, was wounded by a Japanese knee mortar shell which burst in the foxhole. The aid men had difficulty in reaching him and 5 hours elapsed before he could be removed. At the 31st Portable Surgical Hospital shock was apparent and resulted from compound fractures of the right femur and leg, and severe wounds of the right arm, chest, and pelvis. After a plasma transfusion a Steinmann pin was inserted in the distal end of the femur and the lower leg amputated. The patient did not survive the operation, however, and died at 1350 hours, 13 March 1944. Autopsy showed multiple perforating wounds of the right thigh and a compound fracture of the femur. The right lower leg had been amputated at the junction of the upper and middle thirds, and a compound fracture of the bones of the left foot and deep lacerations of the scrotum, chest wall and medial aspect of the thigh were present. The abdominal and thoracic cavities were negative. Death was attributed to shock and hemorrhage.

Case 8. [redacted] 117th Engr., 37th Division, while driving a vehicle along a jungle trail was struck by fragments of a Japanese mortar shell which burst in a tree at a distance of 25 feet. He was wounded at 1030 hours, 9 March 1944, and taken at once to the 21st Evacuation Hospital. Severe multiple wounds of the right thigh and buttocks involving the perineum and scrotum were discovered. The sciatic nerve had been transected. After appropriate shock therapy the wounds were debrided and the patient was given a prophylactic injection of 5000 units of gas gangrene anti-toxin. Immediately after a diagnosis of gas gangrene had been established, multiple incisions were made in affected areas in the right groin and thigh. The patient expired at 2045 hours, 10 March 1944, approximately 30 minutes after the termination of the operation. Death was ascribed to gas gangrene infection.

g. Comment on Treatment of the Wounded

Perhaps never in the history of jungle warfare were professional talent and medical facilities so excellent and routes of evacuation so favorable as in this campaign. Hence, the care of the wounded did achieve a very high standard. That this was accomplished is evidenced by the foregoing description of the treatment of all those who were wounded in action and died later.

The first aid treatment was prompt and efficient. Great credit should be given to the aid men who fearlessly exposed themselves, and high approbation to the many who were killed in order that their comrades might live. Plasma was given promptly and in large quantities. Hemorrhage was efficiently controlled in all patients with only two exceptions. Both of these patients bled to death from traumatic amputations of the foot. Bleeding had ceased while the patient was at rest, but began anew during transportation. These patients might have been saved by the use of a tourniquet. Considerable criticism was heard, because sucking wounds of the chest were not tightly sealed by the adequate use of adhesive. However, no patient was known to have died because of this.

The division medical services were adequately staffed to care for the type of surgery they were expected to do. Most of the major surgery was done at the 21st Evacuation Hospital, because of its proximity to the front. The clearing stations and portable surgical hospitals were usually passed by in order to save time in the case of the seriously wounded. Minor surgery was done in the clearing stations. One clearing station sutured approximately fifty superficial wounds and obtained primary healing in all. This was done as a trial and no untoward results ensued as the procedure was limited strictly to superficial fresh wounds. While two portable surgical hospitals were available, they were not necessary in this campaign. A few patients who underwent operation at these hospitals were transferred immediately or shortly after operation before recovering from shock. This factor may have contributed to a fatal termination in some instances. Rapid evacuation of patients to the hospitals was possible, because of excellent roads and more than 80 per cent of all patients reached the hospital within three hours.

The 21st Evacuation Hospital was staffed with well qualified specialists and no patient here failed to achieve adequate specialized care. The value of a neurosurgeon at the front is frequently a disputed point. In island warfare, unless a competent surgeon is assigned locally the patient may have to be evacuated for a distance of hundreds of miles. Hence, the various specialists should be available if possible on the island where combat occurs. Especially is the thoracic surgeon of great value at the front, if the lives of these patients are to be saved. The chief deficiency in the ranks of the specialists is the lack of adequately qualified anesthetists. One such anesthetist was available at the 21st Evacuation Hospital, but when faced with the problem of anesthetizing eight patients simultaneously, his problem was insurmountable. As is the case so frequently it was impossible to determine which deaths to attribute to improper anesthesia. Good anesthesia is of first importance in dealing with wounds which require major surgical procedures in the presence of impending shock.

Plasma was used in large quantities in the hospitals as well as in the forward areas. Blood transfusions were more liberally used in this campaign than in any other in the South Pacific. Over 400 transfusions were given in the 21st Evacuation Hospital with only three reactions. Blood loss was usually great and very large quantities of blood were required to restore blood volume. Blood counts and hemoglobin determinations revealed these huge blood deficits and further confirmation was frequently obtained at postmortem. All blood was donated by troops on the island and furnished from a blood bank maintained at the hospital.

Professional care of the wounded was excellent and even the unavoidable errors of judgment incident to war surgery were at a minimum. There were four patients who died of gas gangrene infections, but only one death could be attributed to an error of surgical judgment. In this instance closure of the wound by suture was responsible. There were no deaths due directly to compound fractures of the extremities. Only three patients died in the rear echelon.

The total mortality among 2,015 treated wounded was 3.7 per cent. The total mortality among 1,788 treated in hospitals was 5.1 per cent. The total operative mortality was 3.5 per cent.



Fig.77

A screened operating room in a clearing station. Note excellent sterile technique.



Fig.77 (a): The jeep ambulance carrying three litters is well adapted for use over jungle trails.



Fig.77 (b): Long and difficult litter carries contributed to some deaths.

7. MORBID ANATOMY

The study of morbid anatomy in battle casualties is limited by the facilities* and the personnel available as well as the circumstances of battle. In the tropics it is still further limited by the number of dead which must be studied before decomposition, which occurs early.

This report includes 395 dead on which 104 postmortem examinations were performed. Explanation for the relative small number of autopsies is two-fold. First, the assigned pathologist was on detached service at Bougainville for less than one-half of the period covered in this study. Second, many deaths occurred on patrol or in areas which remained under enemy fire, and the bodies were not recovered until decomposition had ensued and consequently examinations were omitted.

All autopsies were performed at Bougainville except in three instances in which death occurred in hospitals in the rear echelon. Allied dead numbered ninety nine of which nineteen were Fijian Scouts and their New Zealand Officers. Five Japanese bodies were examined to make the total of 104.

The completeness of the postmortem examinations was determined by the circumstances, such as the condition of the body, whether the cause of death was obvious and the number of bodies awaiting autopsy (largest number was 26 on one afternoon). Every effort was made to determine the cause of death and to record the gross effects of the missile, its wounds of entrance and exit and its effects on tissues and organs.

The wounds of entrance responsible for death are shown in Figs. 78 and 79. In the case of multiple wounds, whenever it was possible to decide which of two or more were responsible for death, the wound which caused instantaneous death, was recorded. Missiles entering the body in the lateral plane are indicated at the extreme edge of the profile diagram. Although the number of wounds is small, this

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* Facilities for postmortem examination were courteously provided by the 21st Evacuation Hospital. The morgue, a screened storage tent with a concrete floor, running water and electric lights exceeded expectations for a combat zone. The tent was surrounded by a six foot canvas wall which helped to isolate it from the hospital wards. Vehicles could reach the area without driving past the ward installations. Technicians to assist with the work were detailed by the 21st Evacuation and the 52nd Field Hospitals. A stenographer and photographer recorded all significant wounds and photographed all recovered missiles, fragments, or foreign bodies. When identification of fragments was difficult, they were taken to the Ordnance Section of the XIV Corps for expert opinion. The Cemetery and Graves Registration Office were conveniently located near the hospital and all dead as they were received at the cemetery were transferred to the morgue for examination.

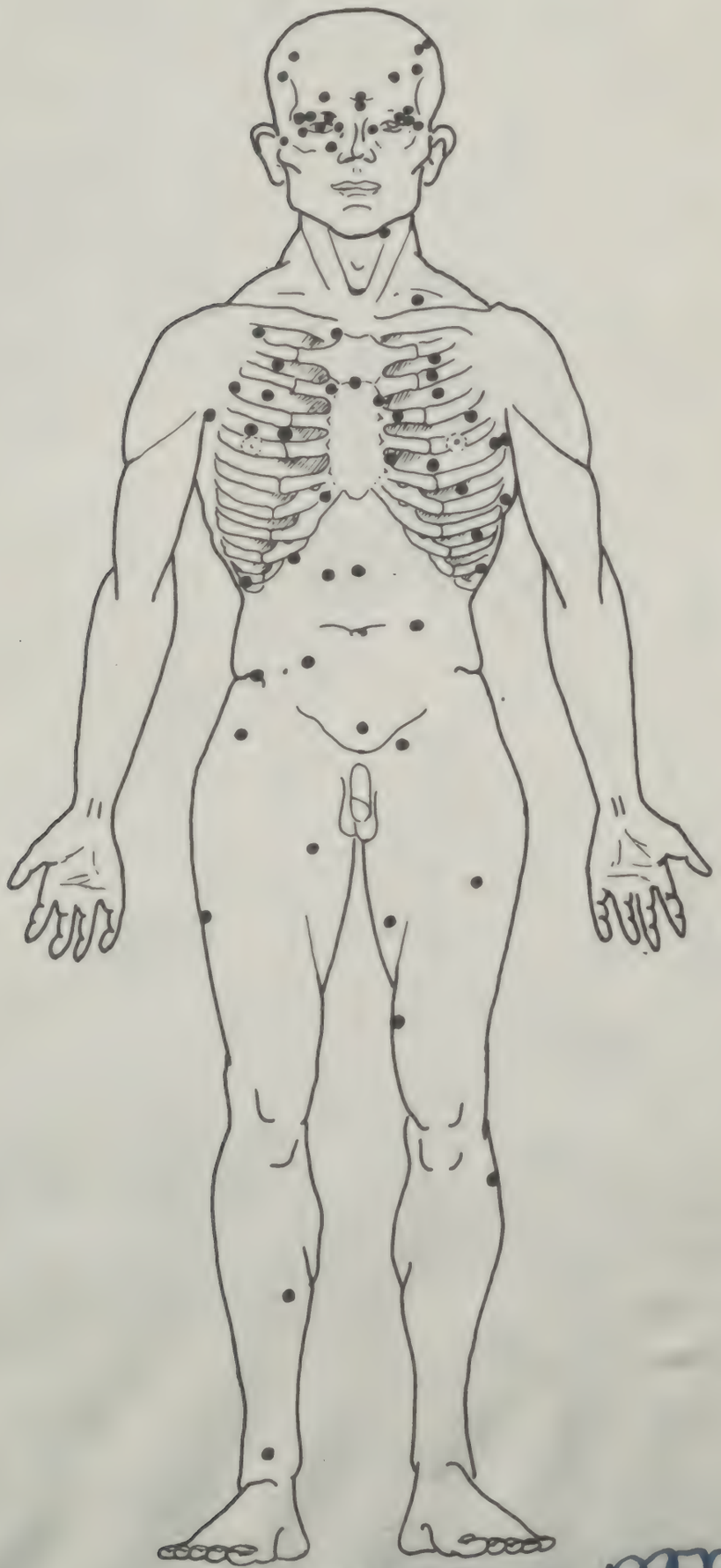
diagram may give some indication of the number of lives which might possibly be saved by protective armour. A recently devised armour chest plate* (9" x 8") covers a square outlined by the sternal notch above, the xiphoid process below and the nipples laterally. Such a plate could possibly have prevented perforations of the chest cavity in sixteen of these chest wounds (59 per cent) illustrated in the anterior view. A central abdominal armour plate (8" x 6") could possibly have prevented 4 of the seven fatal perforations of the peritoneal cavity.

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* A review of body armour as a protection against missiles. Bull. W.B., Page 81.

RESTRICTED

MORTAL WOUNDS OF ENTRANCE IN 104 AUTOPSIES

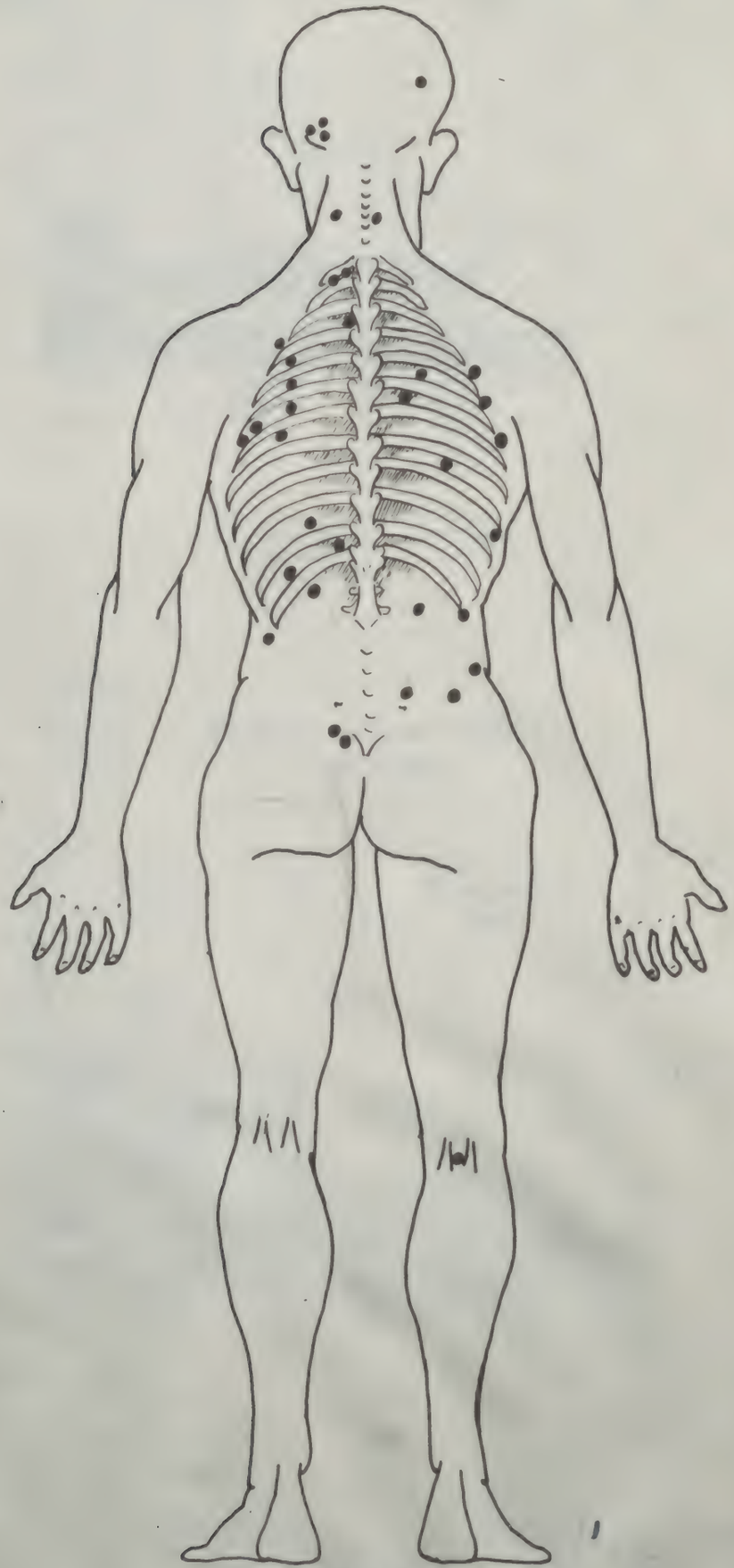


ANTERIOR

FIG. 78

113 A

MORTAL WOUNDS OF ENTRANCE IN 104 AUTOPSIES



POSTERIOR

Fig. 79

113B

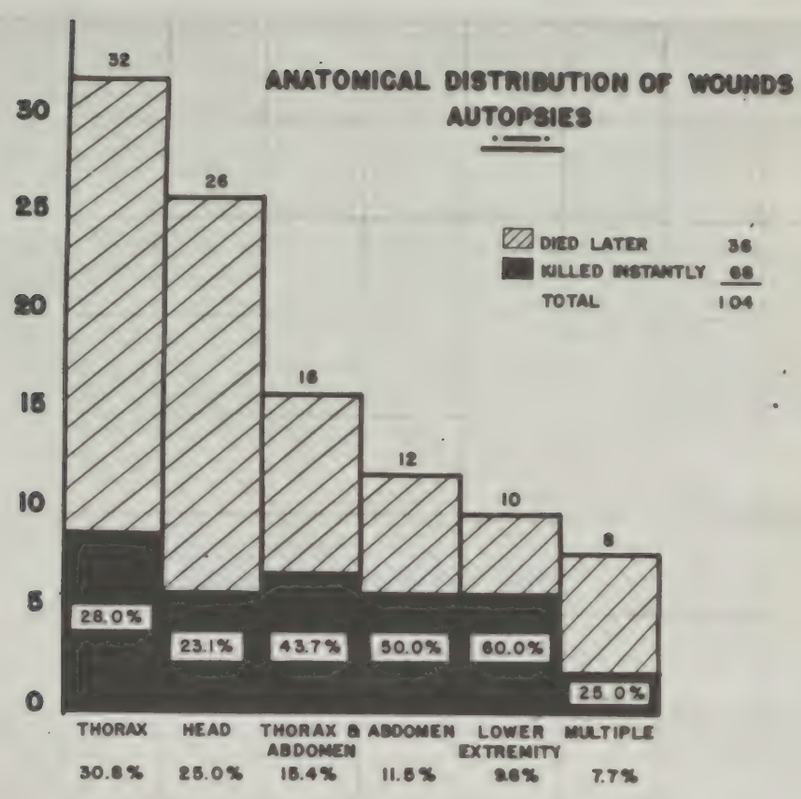

ANATOMICAL DISTRIBUTION OF WOUNDS
AUTOPSIES
DIED LATER 36
KILLED INSTANTLY 68
TOTAL 104
32
26
16
12
10
8
28.0%
23.1%
43.7%
50.0%
60.0%
25.0%
THORAX 30.8%
HEAD 25.0%
THORAX & ABDOMEN 15.4%
ABDOMEN 11.5%
LOWER EXTREMITY 9.6%
MULTIPLE 7.7%

Fig.80

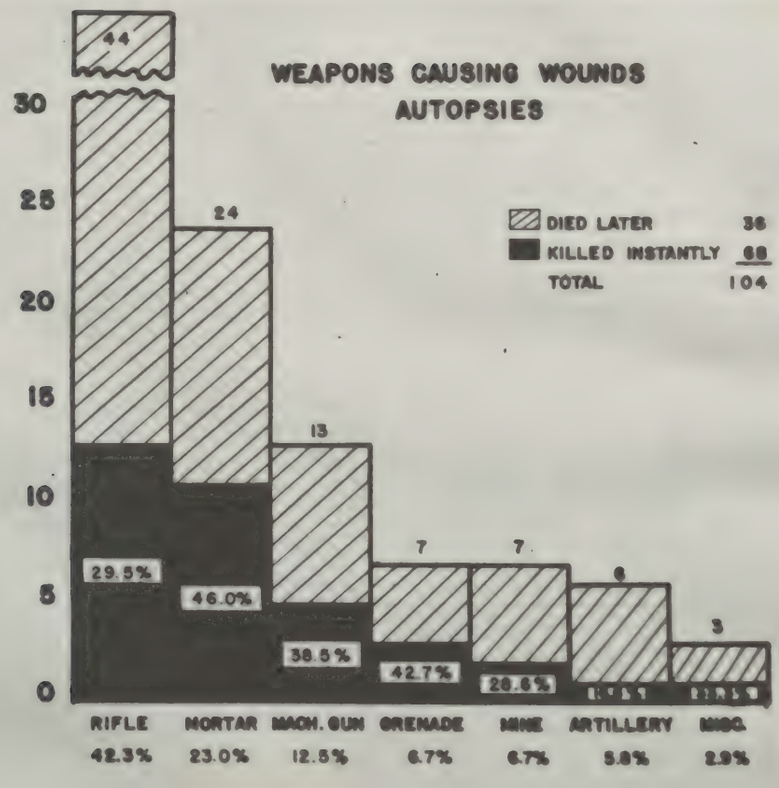

WEAPONS CAUSING WOUNDS
AUTOPSIES
DIED LATER 36
KILLED INSTANTLY 68
TOTAL 104
44
24
13
7
7
6
3
29.5%
46.0%
38.5%
42.7%
28.6%
RIFLE 42.3%
MORTAR 23.0%
MACH. GUN 12.5%
GRENADE 6.7%
MINE 6.7%
ARTILLERY 5.8%
MISC. 2.9%

Fig.81

a. Morbid Anatomy of Wounds by Region

The autopsied dead were classified under anatomical regions according to the location of the wound considered responsible for death. In many instances multiple wounds were present. For this reason it was necessary to reserve the classification "Multiple Wounds" for those cases in which two or more wounds could have been responsible for death. There were 104 postmortem examinations, sixty eight of these dead were killed instantly and thirty six were wounded in action and died later.

(1) Head. In this study twenty six (25 per cent) of the autopsied dead sustained fatal head wounds, twenty of these were killed instantly and six were wounded and died later. Characteristic of this group was the extent and magnitude of the fragmentation of the skull found at autopsy. Extensive comminution of the vault with radiating basal fracture lines was almost invariably present in these compound fractures. Indriven bone splinters were common. The accompanying severe laceration, herniation or avulsion of the brain was obviously the cause of death in all head cases. None of the four patients on whom operation was undertaken survived longer than forty eight hours. In three of these an apparently hopeless prognosis existed from the time of injury.

(2) Thorax. There were thirty two (30.8 per cent) deaths from thoracic wounds, and of this number twenty three died instantly. Almost half (46.2 per cent) of all deaths resulted from a combination of thoracic and thoracico-abdominal wounds. Remarkable to note was the widespread destruction produced by high velocity bullets. Gross damage or "blast effect" in the opposite lung by such missiles was clearly demonstrated in six instances and later confirmed by microscopic sections. In two such cases death was attributed to cardiac failure and in these right ventricular dilatation was found. It was suggested that the blast injury may have produced a partial obstruction of the pulmonary circulation. The rapid administration of intravenous fluids may have contributed to the cardiac dilatation.

Laceration of the lung by perforating or penetrating missiles was present in all cases. The left lung was involved in fifteen cases, the right in nine and in eight instances bilateral lesions were present. Injury to the lung alone resulting in massive unilateral hemothorax caused death in thirteen cases. It was not uncommon to find three to four liters of blood in the pleural cavity. Seven of these patients survived to undergo operation, the others died instantly. The size of the various external chest wall wounds bore no relation to the amount of underlying damage. Particularly striking were the small external wounds of the high velocity bullet which were so frequently accompanied by extensive laceration and destruction of intrathoracic structures. The lower velocity fragments of explosive shells and bombs as a rule produced more extensive external defects. Indriven bone (rib) fragments were common. With the exception of Case 38, in which a metal button was removed, no foreign material was recovered.

In order of frequency, perforation or laceration of the intrathoracic structures occurred as follows: heart, eight; aorta, five; pulmonary artery, four; and trachea and esophagus two. The thoracic cord was transected in three cases, and the cervical cord in one. Wounds of the heart and great vessels were found in approximately 50 per cent of these cases. Hemorrhage was the cause of death in 85 per cent of thorax wounds.

(3) Thoracico-Abdominal Wounds: Multiple lesions of the abdominal and thoracic cavities in the same individual accounted for sixteen (15.4 per cent) deaths. Only those cases in which one missile was responsible for the combined injury are included in this group. The wound of entry was through the thoracic wall in twelve of the sixteen cases. Nine were killed instantly and the remaining seven underwent operation and died later. Four patients had thoracotomy, two laparotomy, and one had both laparotomy and thoracotomy. Five of these patients died within twenty four hours from hemorrhage and shock, one after eight days from secondary hemorrhage and one (Case 68) after six days from cardio-respiratory failure.

The cause of death in fifteen of the sixteen cases was hemorrhage and shock, hemothorax and hemoperitoneum being frequently combined. The lung was injured in all cases, the heart perforated in one, the thoracic aorta in one and the abdominal aorta in another. The abdominal organs injured in order of frequency were liver, spleen, hollow viscus, kidney and pancreas.

(4) Abdomen. There were twelve (11.5 per cent) fatal abdominal wounds. Death resulted from hemorrhage in five of the six patients who died instantly, and in the sixth patient was due to shock from evisceration. Of the six patients who had laparotomy none lived longer than four days following operation. In these cases death was attributed to hemorrhage in one, to paralylic ileus and uremia in one (Case 84), and to peritonitis in four.

Multiple lesions were usually present. In order of frequency the abdominal organs injured were as follows: jejunum, ileum, transverse colon, and rectum, eleven; major vessels, five; kidneys, four; liver, two; pancreas, two; and spleen, one. Fractures of the vertebral bodies were found in four instances. Damage to the spinal cord occurred in one case and to the cauda equina in another.

(5) Lower Extremities. Wounds of the lower extremities were responsible for ten (9.6 per cent) deaths. Hemorrhage from the femoral artery accounted for death in the four soldiers who died instantly. In the others, both Japanese and about whom little is known, death apparently resulted from shock associated with severe compound fractures of the femur. Six patients were wounded and died later; four of this group underwent operation. Gas gangrene accounted for death in three (two Japanese and one American) patients, hemorrhage in two, and uremia in one.

(6) Multiple Wounds. Under this heading are classified those cases in which two or more wounds could have been the cause of death. In the six who died instantly, the following wound distribution was present: head and abdomen, two; head, thorax, and abdomen, one; thorax and multiple fractures of the femur, and extensive multiple wounds, one; and head with multiple fractures of the femur and tibia and fibula, one. In all cases, the immediate cause of death was hemorrhage, extensive brain damage or shock or a combination of these three.

There were two patients who had undergone operative procedures. One who sustained a traumatic amputation of the leg and multiple wounds and fractures, died from shock within ten hours. The second patient died from gas gangrene after forty eight hours following fracture of the femur and other extensive wounds.

(7) Summary

(a) 1. Hemorrhage frequently occult, is the most common cause of death.

2. Extensive brain damage is the second most common cause of death.

3. It is impossible to determine with accuracy the causative missile from the appearance of a wound.

4. The extent of the underlying structural damage bears no constant relationship to the size of the wound of entrance or exit.

5. Foreign material, except for the wounding missile is seldom found.

6. Contralateral brain and lung damage from high velocity missiles is a frequent finding. Blast effect on the contralateral lung may result in sequelae further impairing the pulmonary circulation.

7. High velocity missiles striking large blood vessels or solid organs usually produces an explosive effect rather than a perforation.

(b) Causes of Death in 104 autopsies.

Hemorrhage	57	54.8%
Brain or Spinal Cord Damage	27	26.0
Shock not due to Hemorrhage	5	4.9
Peritonitis	4	3.9
Gas Gangrene	4	3.9
Cardiac Failure	2	1.9
Uremia	2	1.9
Pulmonary Edema	1	.9
Pulmonary Embolus	1	.9
Empyema with Sepsis	1	.9
	104	100.0%

b. Morbid Anatomy of Wounds by Weapon

(1) Wounds Caused by Rifle

The rifle was the weapon responsible for death in slightly less than half (42.3 per cent) of the autopsied cases. Table I shows the anatomical distribution of wounds among those killed by rifle fire.

TABLE I

	Killed Instantly	Died Later	Japanese Weapons	U.S. Weapons	Total
Head	12	3	13	2	15
Abdomen Thorax	1	3	4	0	4
Thorax	12	5	15	2	17
Abdomen	2	1	3	0	3
Lower Extremity	3	0	1	2	3
Multiple	1	1	2	0	2
	31	13	38	6	44

(a) Head. Head wounds produced by rifle fire were characterized without exception by extensive destruction of the brain and skull. Laceration, massive herniation or total absence of large portions of the brain were the usual findings. Large areas of boney skull and scalp were frequently avulsed with shattering or widespread comminution of the residual portions of the skull. Oftimes bone fragments were driven deep into the brain tissue. Perforating skull wounds were more common than gutter wounds. Frequently long stellate fracture lines radiated across the base of the skull. Extensive damage was sometimes observed in one hemisphere of the brain, when the traversing missile tract lay entirely in the opposite hemisphere. All these findings were interpreted as additional evidence in support of the modern hypotheses* of wound production by high velocity missiles.

There are no features present to distinguish the wounds produced by the Japanese rifle from those produced by our own rifle, nor are there any dissimilar findings in the wounds of those killed instantly and those who were wounded and died later. Perforating wounds completely traversing the skull are recorded frequently by the Japanese .25 caliber bullet at varying distances from ten feet to 150 yards.

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Perforation of the U.S.helmet by enemy rifle fire was found in six instances. The maximum recorded distance at which this occurred was 100 yards. A sample of the sizes of the entrance and exit wounds of the head produced by the Japanese rifle at various distances follows: 0.6 and 1.2 cm. at 150 yards, 2.5 and 3 cm. at 100 yards, 0.5 and 1.2 cm. at 20 yards, and 3.7 and 8.7 cm. at 15 yards.

(b) Thorax. Fairly typical of extensive thoracic damage caused by the .25 caliber Japanese rifle bullet is Case 40. This soldier was struck in the chest at moderately close range. The entrance wound was situated in the seventh posterior intercostal space, and the exit wound over the clavicle. All ribs from fourth to eighth inclusive were fractured in addition to the clavicle. The upper and lower lobes were severely lacerated and a massive hemothorax was present.

Massive intrathoracic hemorrhage was the immediate cause of death in all those killed instantly, and in two patients who were wounded and died a few hours later. Transection of the spinal cord with fracture of vertebra was present in four instances. In two of these death occurred immediately, and in both cases massive hemothorax was found. In one of the other two cases, death occurred in twenty four hours associated with terminal hyperthermia, and in the other after on month following an extensive empyema complicated by a broncho-pleural fistula.

All rifle wounds of the chest were with two exceptions complete perforating through and through wounds. In both of these instances the enemy .25 caliber bullet failed to perforate the thorax at a distance of twenty five yards.

Sizes of known wounds of entrance and exit at various ranges are shown in Table II.

TABLE II

RIFLE WOUNDS										
Distance (Yds)	-1	5	5	20	20	25	30	30	30	35
Entrance Wound (cm.)	0.6	0.5	1.8	0.5	3x1	0.5	0.6	0.6	0.5	0.5
Exit Wound (cm.)	2.5	1.2	3.8	3.7	3.8x 2.5	1.5 x 1	4.3	2.5	2.5	

(c) Thorax and Abdomen. The terrific force of the .25 caliber Japanese rifle bullet fired at moderately close range (twenty five yards or less) is well demonstrated by the great number of structures and organs injured when the thorax and abdomen is traversed by the same missile. Structures perforated in each of four illustrative cases are listed here: Case 67, anterior chest wall, upper left lobe, left ventricle, right ventricle, right lower lobe, diaphragm, liver, lateral chest wall; Case 71, abdominal wall, jejunum, ileum, transverse colon, liver, diaphragm, lower right lobe, chest wall; Case 68, chest wall, lung, diaphragm, colon, spleen, kidney; Case 69, left elbow (fracture of humerus), chest wall, both lobes of left lung, diaphragm, spleen, kidney, chest wall. The latter patient lived eight days and died of secondary hemorrhage from lung and spleen. Death in the third case occurred on the following day and resulted from cardio-respiratory failure. In the first two cases massive hemothorax and hemoperitoneum were present at autopsy.

(d) Abdomen. The powerful disruptive effect of the rifle bullet on various abdominal structures can be appreciated best by enumerating its destructive effects in the individual case. Three patients were struck in the abdomen by Japanese rifle bullets at distances of twenty yards, seventy five yards and at an unknown distance. Respectively, their important injuries were; in Case 77, fracture of the ileum and sacrum, perforation of the rectum, and massive hemoperitoneum; in Case 78, fracture of the rib and vertebra, extensive lacerations of the liver, kidney, and transverse colon and hemoperitoneum; in Case 81, extensive lacerations of the kidney and liver with hemoperitoneum. Common to all these cases and characteristic in the wounds of the solid organs in the kidney, liver, and spleen was the widespread "shattering" and fragmentation produced by the explosive effect of the missile in its passage.

(e) Lower Extremity. A Fijian soldier (Case 87) was struck in the groin by an enemy rifle bullet which severed the femoral artery and vein. He died within a few minutes from exsanguination. A Japanese soldier (Case 89) sustained a severe compound comminuted fracture of the middle third of the femur and died from shock several hours later despite therapy. Cursory examination of the decomposed body of another Japanese soldier (Case 90) revealed an extensive comminuted compound fracture of the femur with a very large wound of exit (16.6 x 13.9 cm.), but with intact femoral vessels. In these last two cases, death apparently resulted from severe shock without significant concomitant hemorrhage.

(f) Multiple. Two patients sustained multiple rifle wounds. One of these (Case 101) died instantly, the other (Case 103) died two days later from peritonitis and gas gangrene.

(2) Mortars and Grenade Discharges.

Mortar fire accounted for death in approximately one fourth (23.1 per cent) of the autopsied cases.

The anatomical distribution of wounds among those killed by this weapon is shown in Table III.

TABLE III

	Killed Instantly	Died Later	Japanese Weapons	U.S. Weapons	Total
Head	4	2	3	3	6
Abdomen Thorax	2	2	4	0	4
Thorax	5	1	4	2	6
Abdomen	1	2	2	1	3
Lower Extremity	0	4	2	2	4
Multiple	1	0	1	0	1
Total	13	11	16	8	24

It is interesting to observe that the immediate lethal effect of the low velocity mortar fragment is appreciably less than that of the high velocity rifle bullet. Only slightly more than half of the autopsied dead, wounded by the mortar, died instantly; whereas, two-thirds of all autopsied cases struck by rifle bullets were killed instantly.

In cases in which perforation of the skull occurred, the size of the skull wounds and distance from the burst are known in three. At twenty five yards a fragment (3 x 1 x 0.8 cm.) of a U.S. 90 mm. shell perforated the skull and resulted in death two hours later from the extensive brain damage (Case 12). The entrance wound in this case measured 2.5 cm. in diameter. A U.S. 90 mm. shell exploding at a distance of twenty yards produced a large gutter wound in the skull measuring 6.2 x 1.8 cm. (Case 3). Death followed in three hours. A small metal fragment (20 x 4 x 1 mm.) was recovered from the inner table of the skull. In the third instance (Case 26) a soldier was struck by a fragment from a Japanese 90 mm. shell at a distance of seven yards. An entrance wound of 2.5 x 0.5 cm. was produced. This soldier expired after twelve hours from the cerebral injury.

A fairly characteristic feature of mortar wounds of the thorax was the extraordinary extent of the defect identified as the wound of entrance. For example, a Fijian soldier (Case 29) was killed instantly by a U.S. 90 mm. shell which burst twenty yards away. Even from that distance the fragment completely traversed the thorax and produced a wound of entrance 8.2 x 6.8 cm., and a wound of exit 20 x 12.5 cm. In another instance (Case 46) an entrance wound defect over the region of the scapula measuring 20 x 10 cm., was produced by a fragment of a 90 mm. Japanese ~~artillery~~ mortar shell bursting at a distance of twenty yards. On the other hand a mortar fragment in its greatest dimension measuring a little more than 1.0 cm., caused death from intrathoracic hemorrhage (Case 48). This fragment originated from an enemy 90 mm. shell burst at ten yards. The wound

of entrance in this case measured only 1.5 cm. One patient (Case 51) survived for a period of three days following severe chest injuries resulting from the explosion of a U.S.4.2 mortar shell at a distance of three yards.

In the abdomen extensive laceration of multiple organs and structures was frequently observed. Death in these if immediate, resulted from hemorrhage and shock. Two patients surviving for three and five days respectively after laparotomy died of peritonitis. The first patient (Case 83) was struck in the abdomen by a fragment of an enemy 90 mm. mortar shell at a distance of twenty five yards. Multiple perforations of the jejunum and colon resulted but unfortunately the jejunal lacerations were overlooked at operation. The second patient (Case 84) was wounded by the burst of a 4.2 U.S. mortar shell at a distance of three yards. The largest external defect in this case was an entrance wound measuring 10 x 5 cm. over the region of the right iliac crest. Laceration of the right kidney and cauda equina, and a large retroperitoneal hematoma were found at operation.

There were four autopsied dead who had sustained lower extremity wounds only. One of these deaths might have been prevented. In this case a soldiers foot was blown off by the point-blank burst of an enemy shell (Case 91). Evacuation of this patient was effected at night twenty four hours later. In the process of transportation by litter and unknown to the aid men, delayed hemorrhage occurred and the soldier expired. In another case (Case 93) amputation was performed one day after injury, because of damaged blood supply to the extremity. This patient died five days later with uremia, the cause of which was unknown. A U.S. 81 mm. "short" exploded between the legs of a soldier (Case 94) who lived thereafter for six hours. Traumatic amputations of both lower extremities resulted, the left thigh and right leg at the level of their upper thirds. A Japanese soldier (Case 96) died of gas gangrene four days after being wounded. The femoral vessels were intact but thrombosed and the femur was not fractured. In this instance the wound on the medial surface of the thigh measured 17 x 16.2 cm.

Two small external wounds resulted from the explosion of a 90 mm. Japanese mortar shell at a distance of two yards in a patient (Case 99) who survived only a few hours. One wound over the parietal region measuring only 1.5 cm. in diameter had resulted in extensive intracranial injury and hemorrhage. The liver and right kidney were extensively lacerated and a massive hemoperitoneum was present. This was the only case listed under "Multiple Wounds" by mortar fire.

(3) Machine Gun. The only distinguishing feature between rifle and machine gun wounds is that the latter are more often multiple. In all other respects wounds produced by rifle and machine gun bullets of like caliber and muzzle velocity are identical. There were twenty six separate wounds in these thirteen dead.

Grouped anatomically the wounds responsible for death were divided as follows: head two, thorax four, thorax-abdomen five, and abdomen four. Eleven were killed by enemy weapons and two by our own weapons. Eight of the thirteen autopsied were killed instantly, with one exception the remaining wounded died within a few hours. Two of the dead were struck by .25 caliber bullets at distances of 150 yards, this being the maximum range recorded. In one of these (Case 27) a perforation of the thorax resulted, the entrance wound of which measured 2 cm. and the exit wound 3 x 1.5 cm. In the other (Case 5) a larger gutter wound of the skull was found measuring 6.5 x 2.5 cm.

(4) Grenades. The grenade produced death in seven (6.1 per cent) of the autopsied cases. Four of these deaths resulted from the U.S.Grenade, and three from the Japanese. The anatomical distribution of fatal wounds among the autopsied dead was; abdomen and thorax, two; thorax, one; abdomen, two; lower extremity, one; and multiple, one. With one exception all patients wounded by grenades had multiple wounds. This soldier (Case 92) while on guard tripped the wire of a U.S.grenade booby trap and was struck in the buttock by a single fragment. He died six days later from gas gangrene. A U.S. grenade exploded in the hand of an American soldier (Case 85) returning from patrol. Multiple abdominal organs and intestinal loops were perforated. Despite laparotomy and supportive treatment, this patient died on the following day. Multiple wounds and massive intrathoracic hemorrhage were found in two soldiers whose deaths resulted from point-blank bursts of our own grenades. In one instance (Case 98) a soldier returning to his own foxhole was mistaken for the enemy and in the other (Case 64) an unexplained explosion occurred in the pocket of a soldier returning from patrol. Three deaths resulted from point-blank explosions of Japanese hand grenades, and in all instances multiple wounding was present. The cause of death was intrathoracic hemorrhage in the two cases in which death was instantaneous. In the other case the patient died after twelve days from generalized suppurative peritonitis due to evisceration following laparotomy. The grenade fragments did not perforate the abdominal cavity. No conclusions can be drawn from these dead as to different effects of the Japanese and U.S. grenades.

(5) Artillery. Of the six autopsied dead by artillery fire, four were killed instantly by our own weapons. Two of these dead (Cases 9 and 16) sustained severe head wounds from 75 mm. shell bursts at distances of five and twelve yards respectively. In the other two cases death resulted from extensive thoracic wounds, produced in one (Case 34) by a 37 mm. enemy shell burst at three yards and in the other (Case 42) by a U.S. shell of unknown caliber at a distance of five yards. One patient (Case 13) was killed instantly and another (Case 57) lived for only a few hours following the explosion of a Japanese shell (probably 15 cm.) at distances of less than two yards.

(6) Land Mines. That the U.S. land mine is a most deadly weapon is convincingly demonstrated by the autopsy findings in seven cases. Each of these dead had many wounds, and all were killed instantly except two. One of the two who survived the initial blast was a Japanese soldier (Case 95). His death later in an American hospital was due to gas gangrene. The other was an American soldier (Case 104) who lived a little more than six hours and died from shock. The postmortem findings in this instance well illustrate the multiplicity of wounds found. The soldier sustained a traumatic amputation of the foot and thirteen penetrating wounds. Present also were compound comminuted fractures of the patella, internal malleolus of the tibia, sacrum and ulna.

Other examples of the extreme degree of trauma caused by these land mines is seen in the cases of five soldiers who were killed instantly. A striking illustration is that of a soldier (Case 102) in whom avulsion of the right and left frontal lobes and part of the right parietal lobe occurred with destruction of the orbit, frontal bone and an area of skull measuring 10 x 6 cm. In addition compound fractures of the tibia (bilateral)., fibula, femur, ulna, and mandible were present. Altogether there were eighteen, widely distributed, perforating and penetrating wounds. One other case will suffice to illustrate the lethal effect of this weapon. Postmortem examination showed seven penetrating and perforating wounds (Case 100). A fragment passed thru the skull fracturing the maxilla, zygoma, and temporal bones, and then made its exit through the fronto-temporal region. In its course the missile destroyed the right frontal lobe. Another fragment entered the abdomen, severed or perforated the pylorus, duodenum, jejunum, and small intestine mesentery, and finally lodged in the bifurcation of the aorta. The peritoneal cavity was filled with blood, the brachial plexus was severed and there were numerous other wounds of the thoracic and abdominal walls and thigh.

In all these instances it is assumed that the victim either stepped directly on the mine or was injured at close range by having tripped a mine wire.

c. Autopsy Protocols

INDEX

Case No.	Name	Wounds By Region	Weapon
1	[redacted]	Head	Rifle*
2	[redacted]	Head	Rifle
3	[redacted]	Head	Mortar*
4	[redacted]	Head	Rifle
5	[redacted]	Head	Machine Gun
6	[redacted]	Head	Mortar
7	[redacted]	Head	Rifle
8	[redacted]	Head	Rifle
9	[redacted]	Head	Artillery*
10	[redacted]	Head	Rifle
11	[redacted]	Head	Rifle
12	[redacted]	Head	Mortar*
13	[redacted]	Head	Artillery
14	[redacted]	Head	Mortar
15	[redacted]	Head	Rifle
16	[redacted]	Head	Artillery*
17	[redacted]	Head	Rifle
18	[redacted]	Head	Rifle
19	[redacted]	Head	Rifle
20	[redacted]	Head	Rifle
21	[redacted]	Head	Rifle
22	[redacted]	Head	Rifle*
23	[redacted]	Head	Mortar
24	[redacted]	Head	Machine Gun
25	[redacted]	Head	Rifle
26	[redacted]	Head	Mortar
27	[redacted]	Thorax	Machine Gun
28	[redacted]	Thorax	Machine Gun
29	[redacted]	Thorax	Mortar*
30	[redacted]	Thorax	Rifle
31	[redacted]	Thorax	Rifle
32	[redacted]	Thorax	Rifle
33	[redacted]	Thorax	Land Mine*
34	[redacted]	Thorax	Artillery*
35	[redacted]	Thorax	Mortar
36	[redacted]	Thorax	Mortar
37	[redacted]	Thorax	Rifle*
38	[redacted]	Thorax	Rifle
39	[redacted]	Thorax	Grenade
40	[redacted]	Thorax	Rifle
41	[redacted]	Thorax	Rifle
42	[redacted]	Thorax	Artillery*
43	[redacted]	Thorax	Rifle
44	[redacted]	Thorax	Rifle
45	[redacted]	Thorax	Rifle
46	[redacted]	Thorax	Mortar
47	[redacted]	Thorax	Rifle
48	[redacted]	Thorax	Mortar
49	[redacted]	Thorax	Rifle

Case No.	Name	Wounds by Region	Weapon
50	[redacted]	Thorax	Rifle
51		Thorax	Mortar*
52		Thorax	Rifle
53		Thorax	Rifle*
54		Thorax	Machine Gun
55		Thorax	Rifle
56		Thorax	Rifle
57		Thorax	Artillery
58		Thorax	Machine Gun
59		Thorax-Abdomen	Machine Gun
60		Thorax-Abdomen	Machine Gun
61		Thorax-Abdomen	Mortar
62		Thorax-Abdomen	Grenade
63		Thorax-Abdomen	Land Mine*
64		Thorax-Abdomen	Grenade*
65		Thorax-Abdomen	Mortar*
66		Thorax-Abdomen	Machine Gun
67		Thorax-Abdomen	Rifle
68		Thorax-Abdomen	Rifle
69		Thorax-Abdomen	Rifle
70		Thorax-Abdomen	Mortar
71		Thorax-Abdomen	Rifle
72		Thorax-Abdomen	Machine Gun*
73		Thorax-Abdomen	Machine Gun
74		Thorax-Abdomen	Mortar
75		Abdomen	45 cal.Pistol*
76		Abdomen	Mortar
77		Abdomen	Rifle
78		Abdomen	Rifle
79		Abdomen	Machine Gun*
80		Abdomen	Machine Gun
81		Abdomen	Rifle
82		Abdomen	Grenade
83		Abdomen	Mortar
84		Abdomen	Mortar*
85		Abdomen	Grenade*
86		Abdomen	Aerial Bomb*
87		Lower Extremity	Rifle
88		Lower Extremity	Bayonet*
89		Lower Extremity	Rifle*
90		Lower Extremity	Rifle*
91		Lower Extremity	Mortar
92		Lower Extremity	Grenade*
93		Lower Extremity	Mortar
94		Lower Extremity	Mortar*
95		Lower Extremity	Land Mine*
96		Lower Extremity	Mortar*
97		Multiple	Land Mine*
98		Multiple	Grenade*
99		Multiple	Mortar
100		Multiple	Land Mine*
101		Multiple	Rifle
102		Multiple	Land Mine*
103		Multiple	Rifle
104		Multiple	Land Mine*

* U.S. Weapon



CASE 1

CASE 1

[redacted] 164th Inf., while walking through thick jungle towards our lines returning from patrol, was mistaken for the enemy and shot through the head with an M-1 rifle at a distance of 30 yards by a fellow soldier. He was wearing a helmet when struck and this was perforated in the front and back. [redacted] was killed instantly at 1700 hours 1 April 1944.

Examination revealed a perforating wound of the skull. The bullet produced a wound of entrance (3 cm. in diameter) through the left orbit and a wound of exit (2.5 cm. in diameter) at the junction of the parietal and occipital bones. Comminution of the cranial vault with diffuse disruption of the brain was present.

The photograph demonstrates the widespread destruction of the cranial vault and brain. (scalp retracted).

CASE 2

[redacted] 1st Bn., FIR (Fijian), while on patrol was standing behind a tree when struck by a .25 caliber Japanese bullet fired from a distance of 20 yards. He was killed instantly on 31 March 1944.

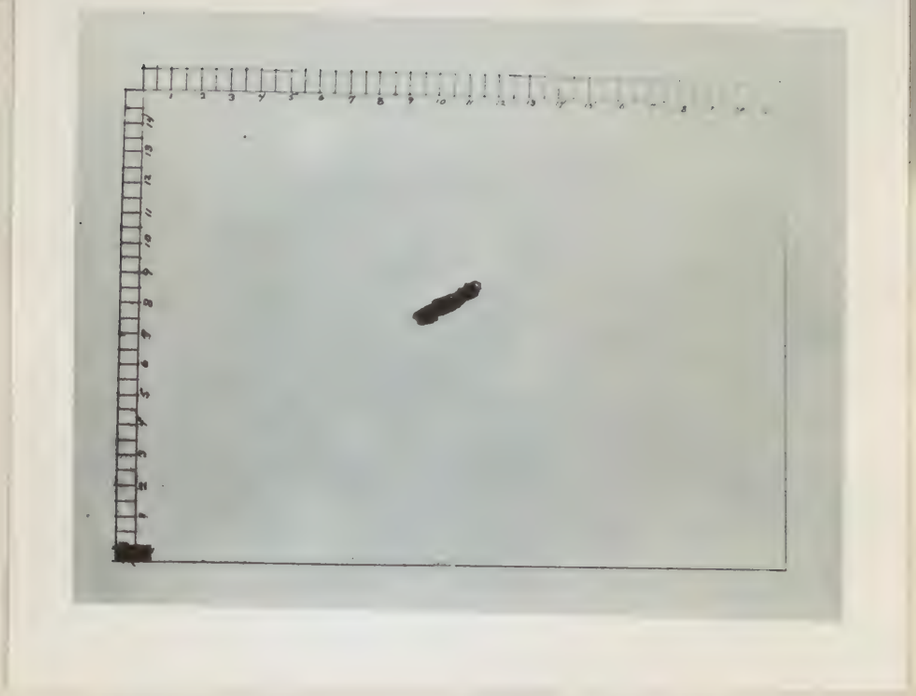
Examination revealed a perforating wound of the head. The entrance wound (0.5 cm. in diameter) was situated over the lateral border of the right supra-orbital ridge and the exit wound (1.2 cm. in diameter) over the occipital bone.



Stellate fractures of the frontal and occipital bones radiated from both perforations. The frontal and parietal lobes of the brain were perforated, and the cerebellum was grooved.

In the photograph the wounds of entrance and exit are demonstrated by the insertion of instruments.





CASE 3

CASE 3

[redacted] 3rd Bn. FIR (Fijian, while on patrol was standing digging a foxhole when struck by a fragment from a U.S.90 mm shell. The shell exploded on the ground at 20 yards distance. He was wounded at 1700 hours, 30 March 1944, and died 3 hours later in the hospital. Death was attributed to severe brain damage.

Examination revealed a gutter wound (6.2 x 1.8 cm.) in the right frontal region. A stellate fracture involved the vault of the skull. The fragment coursed obliquely through the right cerebral hemisphere to the posterior aspect of the left parietal lobe. A metallic fragment (20 x 4 x 4 mm.) was recovered at this point and was found to be partially imbedded in the inner table.

The photographs illustrate the extensive fracture of the skull and the recovered fragment.

CASE 4

[redacted] 129th Inf., crouching behind a tree stump stood to throw a hand grenade and was struck in the head by a .25 caliber Japanese bullet fired from a distance of 10 feet; he was wearing a helmet which was perforated on the left side. [redacted] was killed instantly at 0930 hours, 24 March 1944.

Cursory examination* revealed a perforating wound of the left

* On this afternoon twenty six bodies were received and since time did not permit a complete examination of all cases, some of these in which the cause of death was obvious received only cursory examinations.

[redacted]

side of the skull. The entrance wound involved the left orbit. The exit wound was found over the left parieto-occipital region. Brain tissue exuded from both openings. The cranial vault was severely comminuted and the left cerebral hemisphere destroyed.



CASE 5

CASE 5

[redacted] FIR (Fijian), while on patrol peered over a ridge and was struck in the head by a .25 caliber Japanese machine gun bullet fired from a distance of 150 yards. He was killed instantly at 1000 hours, 26 March 1944. After death from the head wound, he was struck again in the chest by a fragment from an artillery shell.

Examination revealed a gutter wound (6.5 x 2.5 cm.) in the center of the forehead, a portion of the frontal bone had been blown away. Fracture lines radiated through the temporal, parietal, and occipital bones. Both frontals and the right temporal lobes were lacerated. A bullet was recovered from the right temporal fossa. The chest was penetrated by a shell fragment entering through a wound (10 x 5.6 cm.) in the left 7th and 8th intercostal spaces in the anterior axillary line. In its course the fragment fractured the 8, 9, 10, and 11th ribs, lacerated the left lower lobe, the upper and lower right lobes, fractured and perforated the bodies of the 7th and 8th dorsal vertebrae, transected the spinal cord and fractured the 3rd, 4th

5th and 6th ribs at the costovertebral junctions. The fragment was lodged in the subcutaneous tissue of the right posterior chest wall.

The photograph shows the two recovered fragments.



Case 6



Case 6



CASE 6

CASE 6

[redacted], 117th Engr., while lying in an open foxhole in a cleared area of the jungle was struck by fragments of a Japanese mortar shell. The shell exploded on the ground at a distance of 1 yard. He was killed instantly at 2015 hours, 24 March 1944.

Examination revealed a penetrating wound of the head. The entrance wound (2.5 cm. in diameter) perforated the left occipital bone. There were severe comminution of the cranial vault and several fracture lines continued inferiorly through the base of the skull traversing the foramen ovale and cribiform plate. The left occipital and temporal lobes were severely lacerated and small indriven bone fragments were removed from these lobes. Two metal fragments were recovered from the depth of an irregular laceration of the left cerebellar hemisphere. The fragments measured 15 x 5 x 1 mm. and 15 x 10 x 2 mm.

Photographs show the extensive skull fractures and the recovered fragments.

CASE 7

[redacted] 129th Inf., was lying behind a tree root and was struck by a Japanese .25 caliber bullet fired from a distance of 10 yards. He was killed instantly at 1000 hours, 24 March 1944.

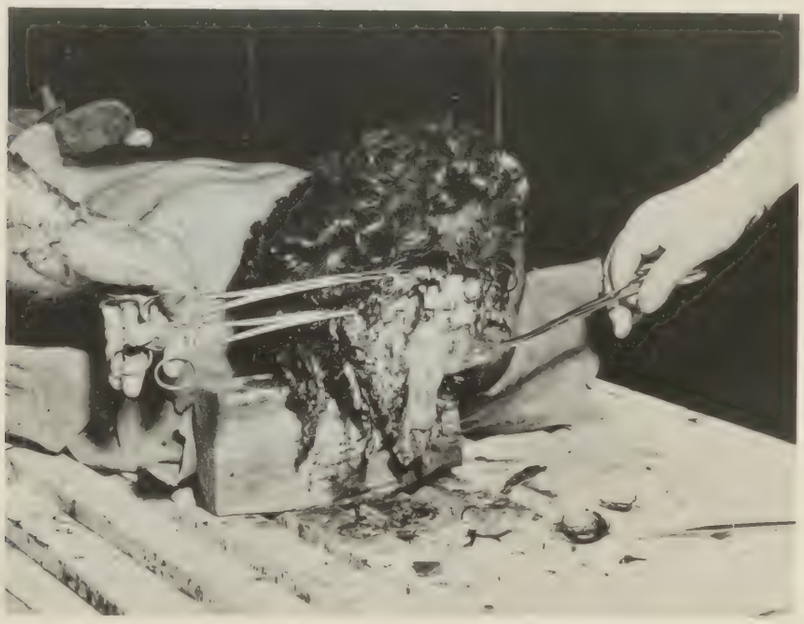
Cursory examination revealed a perforating wound of the skull. The entry wound traversed the right orbit and the

RESTRICTED

[redacted]

exit wound was found over the parieto-occipital region. The cranial vault was extensively fractured and earlier destruction of the right cerebral hemisphere was evident.

Photograph shows the large wound of exit with brain tissue evident.

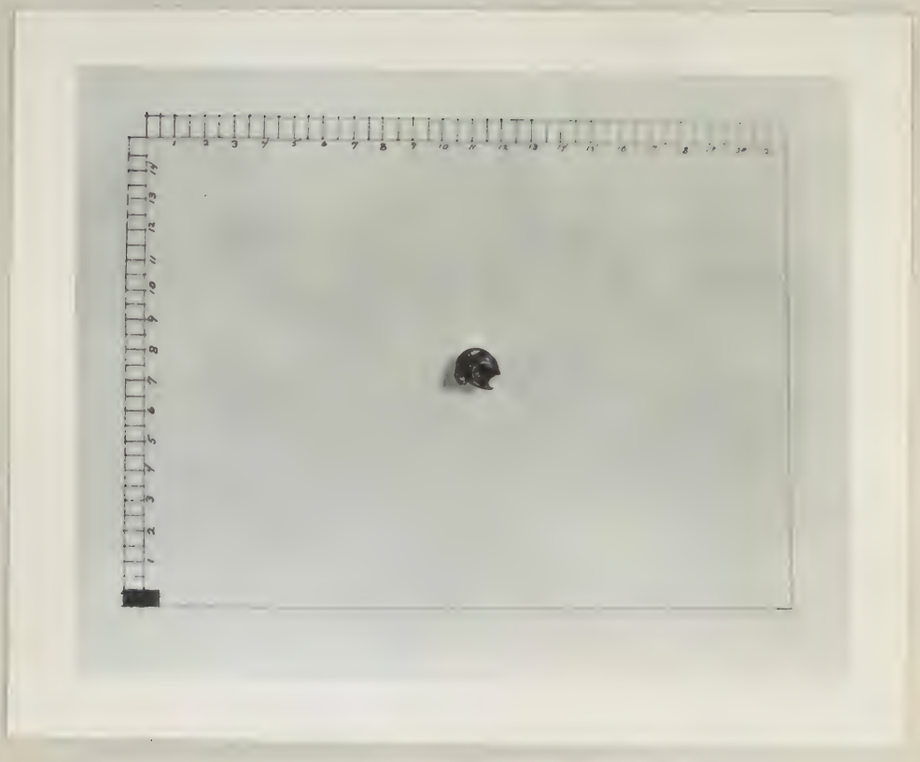


CASE 7



CASE 8

RESTRICTED



CASE 8.

CASE 8

[redacted], 129th Inf., 37th Division, was standing on his bunk in an open tent in battalion headquarters firing at the enemy, when struck by a .25 caliber Japanese bullet fired from a distance of 25 yards. He was killed instantly at 0630 hours, 24 March 1944.

Examination revealed a gutter wound (5 x 2½ cm.) of the left parietal region. Brain tissue exuded through the perforation in his helmet. Lacerated brain tissue, portions of the frontal and parietal lobes, was herniated through the wound. Marked subgaleal hemorrhage was present. The cranial vault was comminuted by stellate fractures. Both hemispheres of the brain were extensively lacerated. A mushroomed .25 caliber bullet was found in the right anterior fossa.

Photographs show the severe comminution of the skull (scalp retracted). The missile was identified as a flattened .25 caliber bullet.

CASE 9

[redacted], 164th Inf., while on patrol in cleared jungle lying in an open foxhole, was struck by a fragment of U.S. 75 mm. shell which fell short. The shell exploded on the ground at a distance of 5 yards. He was killed instantly at 1600 hours on 26 March 1944.

Examination revealed an extensive jagged wound traversing the left side of the head. The occipital, parietal and temporal bones were almost entirely destroyed. Only rudimentary portions of the left cerebral hemisphere remained.



CASE 10

[redacted] PFC, peering over the edge of an open foxhole to fire at the enemy was struck by a .25 caliber Japanese bullet fired from a distance of 15 yards. He was killed instantly at 1400 hours, 1 April 1945. The body was not recovered immediately and received other wounds from high explosive fragments after death.

Examination revealed a perforating wound of the head and multiple wounds of the extremities. The point of entry (3.7 cm. in diameter) was located at the inner canthus of the left eye and the exit wound (6.7 cm. in diameter) at the vertex of the skull. The skull was comminuted and there was almost complete destruction of the left half of the brain. Present in addition were: a perforated wound of the right elbow associated with compound comminuted fracture of the radius, a perforated wound of the soft parts of the right calf, and an extensive gutter wound of the left hand.

The photograph shows the steel fragment removed from the left hand.

CASE 11

[redacted], Anti-Tank Co., 129th Inf., was crouching and moving forward in a skirmish line when struck by a Japanese .25 caliber bullet fired from a distance of 20 yards. He was killed instantly at 1300 hours, 24 March 1944.

Cursory examination revealed an extensive gutter wound 15 x 10 cm. involving the left temporal, occipital and parietal regions. Large portions of these bones and underlying brain were absent. Extensive comminution of the remaining cranial vault was present.

The photograph shows the destructive effect of the missile.



CASE 11

CASE 12

[redacted]. FIR (Fijian), while on patrol was standing digging a foxhole when struck by a fragment of a U.S. 90 mm shell. The shell exploded on the ground 25 yards distant. He was wounded at 1700 hours, 30 March 1944, and died 2 hours later. Death was caused by extensive brain damage.

The wound of entry (2.1 cm. in diameter) in the head was located 2 cm. above the right tragus. Brain tissue exuded from this wound. The fragment perforated the temporal bone producing stellate fractures of the temporal and frontal bones. The wound tract traversed the right temporal,

CONFIDENTIAL



Case 11



Case 12

RESTRICTED

frontal and left frontal lobes. A fragment (3 x 1 x 0.8 cm) was found in the left frontal lobe. Examination revealed additional wounds; traumatic amputation of the left thumb, extensive laceration of the dorsum of the left hand and wrist and perforating wounds of the soft tissue of the anterior, right and left mid-thighs.

One photograph shows a metal probe inserted into the wound of entry in the head, evident also is the extensive hand wound . The metal sliver recovered from the brain is shown in the other photograph.

CASE 13

[redacted], 182nd Infantry, while in a covered pillbox on top of a hill was struck by fragments from a 150 mm Japanese shell which exploded on the ground 1 yard from the hole. He was killed instantly at 1400 hours, 26 March 1944.

Examination revealed a gutter wound (15 x 5.5 cm.) of the left side of the neck with extensive soft tissue damage and transection of the external jugular vein. Another gutter wound (10 x 3.7 cm.) extended obliquely across the 5th and 6th cervical vertebrae. The vertebrae were shattered. At autopsy the dura was opened, the cervical cord exposed and found intact. No foreign bodies were found.



CASE 14.



CASE 14

CASE 14

[redacted] 129th Infantry, was found dead in the 129th sector on the 24 March 1944. He was struck in the left arm and leg by a Japanese .25 caliber bullet. The head wound is believed to have been caused by a Japanese mortar fragment.

Cursory examination revealed perforating wounds of the soft parts of the left thigh and arm. A severe penetrating wound through the left orbit was present as illustrated in the photograph. Marked comminution of the cranial vault was found with brain tissue exuding from the head wound.

CASE 15

[redacted] 132nd Infantry, was on patrol duty and had bivouaced in the open for the night. During the middle of the night he stood up to void and was shot by an apprehensive fellow soldier with an M-1 rifle at a distance of 10 yards. He was killed instantly at 2550 hours, 21 April 1944.

Examination revealed a perforating wound of the neck. The entrance wound (1.2 cm. in diameter) penetrated the left submental triangle and the exit wound (12.5 x 7.5 cm.) occupied the posterior cervical region from the 3rd to the 6th vertebrae. The 4th and 5th vertebrae were shattered, the cord was exposed and was partially severed at the same level.

[redacted]



CASE 16

CASE 16

[redacted] 164th Inf., while on patrol in the jungle was lying on a slope under a tree when struck by a fragment of a U.S. 75 mm. shell which fell short. The shell exploded in a tree 12 yards above the soldier. He was killed instantly at 1600 hours 26 March 1944.

Examination revealed a penetrating wound of the left occipital region 3.7 cm. in diameter. Brain tissue exuded through this wound. The fragment pierced the left occipital bone, left occipital lobe and left cerebellar hemisphere. A shell fragment was found on the inferior surface of the cerebellum. A linear fracture line extended across the left occipital, parietal and temporal bones.

The fragment recovered which is shown in the photograph measured 6 x 5 x 4 mm.

CASE 17

[redacted], 129th Inf., while walking up a jungle trail was struck by a Japanese .25 caliber bullet fired from a distance of 100 yards. He was killed instantly 1320 hours 24 March 1944.

Examination revealed a perforating wound of the head. The wound of entrance (2.5 cm. in diameter) traversed the right infraorbital ridge, the exit wound (3 cm. in diameter) was located in the left parieto-occipital region. When the body was received the helmet had not been removed and brain tissue was extruded over its surface.

The photograph shows an instrument in the wound of entrance and exit. The perforation in the helmet is evident.

[redacted]



CASE 17



CASE 18

CASE 18

[redacted] was standing in a cleared area digging a foxhole when struck in the head by a .25 caliber bullet. The shot was fired by a Japanese sniper at a distance of over 150 yards. He was killed instantly at 1500 hours 26 March 1944.

Examination revealed a perforating wound of the head, the entrance wound (0.6 cm. in diameter) was posterior to the left mastoid process and the exit wound (1.2 cm. in diameter) at the outer canthus of the right eye. The bullet coursed in a superior and anterior direction and perforated the atlas, it then crossed the foramen magnum and severed the brain stem at the lower level of the pons. The tract continued through the base of the skull, right ethmoid and right orbit to the point of exit.

The photograph shows a catheter in the wound tract.



CASE 19

CASE 19

[redacted] while on duty as a sniper in the jungle, peered over a protecting log and was struck in the head by a .25 caliber bullet. The shot was fired by a Japanese sniper from an unknown distance. He was killed instantly on 24 March 1944.

[redacted]

Cursory examination revealed a penetrating wound of the skull, with the wound of entrance in the left orbit. A compound comminuted fracture of the skull with marked brain destruction was present. The large number of dead received on this day prevented a more complete examination.

The photograph shows the extent of the wound of entry.



CASE 20

CASE 20

[redacted], 129th Inf., was sitting on a log holding a flame thrower when struck in the head by a .25 caliber Japanese bullet fired from a distance of 75 yards. His perforated helmet was found lying on the ground. [redacted] was killed instantly at 1130 hours, 27 March 1944.

Examination revealed a gutter wound 17.5 x 4 cm. involving the left temporal and frontal regions. There were deep lacerations of the frontal parietal and temporal lobes. Disorganized brain tissue filled the wound. Extensive comminution of the cranial vault was found.

The photograph illustrates the extent of the wound.

CASE 21

[redacted] 182nd Inf., while crouched, withdrawing from enemy fire was struck in the back of the neck by a .25 caliber Japanese bullet fired by a sniper from a distance of 35 yards. He was wounded at 0600 hours on 15 March 1944. His death 8 hours later was accompanied by a terminal hyperthermia.

Examination revealed a perforating wound of the posterior cervical region. The entrance wound (0.5 cm. in diameter) was located to the right of the spinous process of the 5th cervical vertebra and the exit wound (5 cm. in diameter) over the vertebral border of the left scapula. A fracture of the transverse process and lamina of the 5th cervical was discovered. The dura and the cord were intact, but the cord was bulbous and hemorrhagic for a distance of 2 cm. Because of the patient's profound shock no operative interference was attempted.

CASE 22

[redacted] (Fijian) while walking towards his own lines returning from patrol was mistaken for the enemy and shot. He was struck in the right side of the head and abdomen by .303 caliber bullets fired from a Lee-Enfield rifle at a distance of 15 yards. He was wounded at 1810 hours on 23 March 1944 and died 2055 hours. The soldier died on the operating table, while an attempt was being made to stop bleeding from the brain.

Postmortem examination revealed a gutter wound of the right side of the head extending from the inner canthus of the right eye to the occipital bone. The diffusely lacerated right cerebral hemisphere was herniated through the wound. Bone fragments had been driven into the brain and extensive hemorrhage was present. The abdominal cavity was filled with blood from severe lacerations of the right kidney and liver.

CASE 23

[redacted], 145th Inf., while standing on the crest of a hill in the open observing mortar fire was struck by a fragment of a Japanese mortar shell. The shell burst on a pillbox 3 yards distant from the soldier. After injury the patient walked to the bottom of the hill, he was then placed in an ambulance and taken directly to the Evacuation Hospital. He was wounded at 1800 hours, 16 March 1944. Craniotomy was performed but the patient died 6 hours later. Death was attributed to severe intracranial hemorrhage.

Examination at autopsy revealed a penetrating wound of the right orbit with destruction of the globe. Craniotomy incision was present. A stellate fracture of the right frontal bone with laceration of the frontal lobe and marked intracranial hemorrhage was found.

UNCLASSIFIED

CASE 24

[redacted], 182nd Inf., while walking through the jungle on patrol was struck by a Japanese machine gun bullet. He was wounded at 1800 hours, 30 April 1944, and arrived at the hospital three hours later. A gutter wound of the left frontoparietal region was debrided and closure of the wound attempted. His death at 1210 hours, 2 May 1944 was accompanied by terminal hyperthermia.

Examination revealed a gutter wound 8.7 x 5 cm. in the left frontoparietal region through which an infected fungus protruded. Closure of the wound at the time of operation had not been complete. Portions of the frontal and parietal bones were absent. Bone edges had been rongeured. From the bone margins stellate fracture lines radiated over the cranial vault. The remnants of the frontal and parietal lobes were grossly infected.



CASE 25

CASE 25

[redacted], 129th Inf., was standing in an open foxhole when struck by a .25 caliber Japanese bullet fired by a sniper from a distance of 75 yards. His helmet was perforated. [redacted] was wounded in action at 1430 hours, 24 March 1944 and died 5 hours later, despite shock therapy.

[redacted]

Examination revealed a gutter wound (15 x 7½ cm.) occupying the right parieto-occipital region. Portions of these bones as well as the underlying cerebral hemisphere were absent. A small metal fragment was recovered from the remaining brain tissue. The right lateral ventricle was filled with blood. Petechial hemorrhages were present in the left half of the brain. Stellate fracture lines coursed through the bones of the vault.

The missile in the photograph is part of the jacket of a .25 caliber Japanese bullet which was found in the brain below the wound tract.

CASE 26

[redacted] 129th Inf., was standing in a covered pillbox when a Japanese 90 mm. artillery shell exploded on the ground 7 yards distant destroying one corner of the box. A fragment of the shell struck the soldier penetrating his skull. He was wounded at 0630 hours, 17 March 1944. Supportive treatment was given and debridement performed. Terminal hyperthermia was present at death 12 hours later.

Postmortem examination limited to the head revealed compound linear fractures of the right parietal and temporal bones. Present also were large extra and subdural hemorrhages. A laceration 2.5 x .5 cm. with a surrounding area of contusion was present in the right temporal lobe. Destruction of the preoptic area was noted.



RESTRICTED



Case 27

CASE 27

[redacted], Fijian Inf., was behind a tree directing his platoon on patrol when struck by a .25 caliber Japanese machine gun bullet fired from a distance of 150 yards. He was killed instantly at 1200 hours, 25 March 1944.

The wound of entrance (2 cm. in diameter) was found over the right 5th intercostal space in the post-axillary line, and the exit wound (3 x 1.5 cm.) at the right sterno-clavicular articulation. The bullet fractures the 4th, 5th and 6th ribs, lacerated the middle and upper lobes of the right lung, and fractures the 1st rib, clavicle and sternum at its exit. A right hemothorax (2500 cc.) was present.

In one photograph the path of the bullet is demonstrated by a catheter lying in the wound tract. The other photograph shows the extensive damage of the thoracic wall, viewed from inner aspect.

CASE 28

[redacted] Fijian Inf., while running in open terrain toward his foxhole was struck by a .25 caliber Japanese machine gun bullet fired from a distance of 5 yards. He was killed instantly at 0500 hours, 24 March 1944.

The entrance wound (1.0 cm. in diameter) was located on the right side of the suprasternal notch. The wound of exit was found in the 5th left intercostal space at the sternocostal junction. In its course the bullet fractured the sternum

[redacted]

and 1st rib, severed the aortic arch and trachea, grooved the esophagus and perforated the left lower lobe. Massive bilateral hemothorax and mediastinal emphysema were present.



CASE 29

CASE 29

[redacted], FIR (Fijian), while on patrol standing and digging a hole was struck in the chest by a fragment of a 90 mm U.S. shell which burst on the ground 20 yards away. He was killed instantly at 1700 hours, 30 March 1944.

The wound of entry (8.2 x 6.8 cm.) in the posterior left chest extended from the level of the 3rd to the 7th rib. The wound of exit (20 x 12.5 cm.) destroyed the anterior chest wall above the nipple. In its course the fragment fractured the left scapula, destroyed all but a small portion of the left lung and lacerated or severed the heart, thoracic aorta, and vena cava.

The photograph shows the enormous wound of exit.

CASE 30

[redacted] 2nd Bn., 129th Inf., was creeping up on a Japanese pillbox when struck by a .25 caliber

RESTRICTED

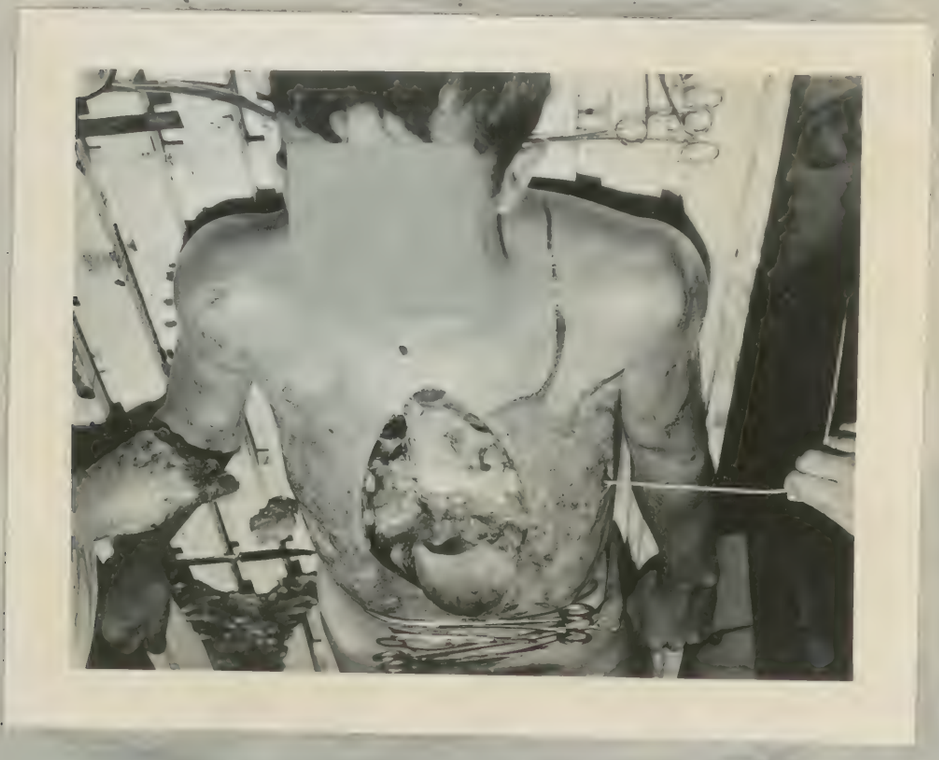
Japanese rifle bullet fired from a distance of 20 yards. He was killed instantly at 1000 hours, 24 March 1944.

Examination revealed the wound of entry (3 x 1 cm.) in the 4th right intercostal space in the mid-axillary line, and the wound of exit (3.8 x 2.5 cm.) in the 3rd left intercostal space in the anterior axillary line. In its course the bullet fractured the 4th rib, and lacerated the left auricle and ventricle. Marked extravasation of blood in both lungs was produced by the concussion. Massive bilateral hemothorax was present.

CASE 31

[redacted] C-F, while walking through the jungle on patrol was struck by a .25 caliber Japanese bullet fired from a distance of 30 yards. He was killed instantly at 1145 hours, 8 April 1944.

Examination revealed the wound of entry (0.6 cm. in diameter) in the anterior left 2nd intercostal space in the mid-clavicular line, and the wound of exit (2.5 cm. in diameter) in the posterior right 5th intercostal space in the posterior axillary line. The bullet in its course perforated the upper left lobe, pericardium, pulmonary artery, the upper right lobe and fractured the right 5th rib in its exit. Hemothorax (left 400 cc., right 1500cc.) and hemopericardium were present.



CASE 32

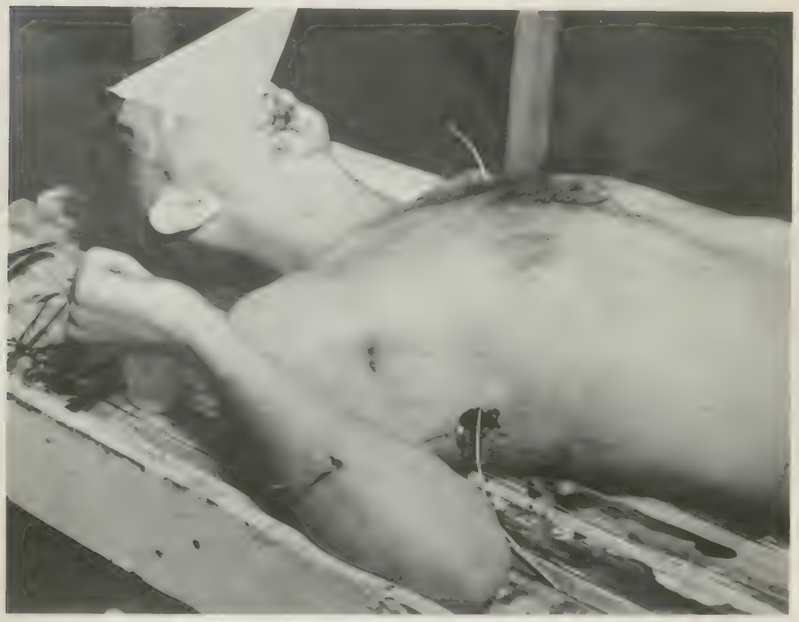
[redacted] RESTRICTED

CASE 32

[redacted] 117th Engrs., while walking and covering the evacuation of a casualty was struck by a .25 caliber Japanese bullet fired from a distance of 35 yards. He was killed instantly 1300 hours, 24 March 1944.

Examination revealed a perforating wound of the chest. The wound of entry (0.5 cm. in diameter) was located in the anterior axillary line in the 4th left intercostal space, and the wound of exit in the 7th intercostal space in the right mid-axillary line. In its course the bullet grooved the anterior medial border of the left lower lobe, pierced the pericardial sac, right ventricle, and right middle and lower lobes. Bilateral hemothorax (2500 cc.) and hemopericardium was present.

In the photograph a catheter has been passed through the wound tract.



CASE 33

CASE 33

[redacted], 129th Inf., 37th Div., while walking beyond the perimeter stepped on U.S. land mine and was killed instantly at 1015 hours, 12 April 1944.

Examination revealed 7 penetrating and perforating wounds. A chest wound was responsible for instantaneous death.

[redacted]

RESTRICTED



CASE 33

One fragment entered the left chest through the second rib in the mid-clavicular line and made its exit through the right 6th intercostal space in the mid-axillary line. In its course the fragment fractured the 2nd rib, lacerated the upper left lobe, avulsed the anterior wall of the ascending aorta, perforated the middle right lobe, lacerated the lower right lobe and fractured the 6th and 7th ribs at its exit. There were 2000 cc. of blood in each pleural cavity. A compound comminuted fracture of the mandible was present. In addition wounds of the right forearm and arm, left frontal region and left thigh were found.

One photograph shows the wounds of the chin, thorax and arm with a catheter threaded through the chest wound, and a probe traversing the perforation of the forearm. Small metal fragments removed from the right arm are shown in the other photograph.

CASE 34

[redacted], 182nd Inf., was in an open foxhole with his "buddy", when struck by fragments of a U.S. 37 mm shell which burst on the ground 3 yards distant. The other occupant was not injured. He was killed instantly at 0710 hours, 24 March 1944.

Examination revealed a perforating wound of the chest. The entrance wound (7.5 x 5 cm.) was in the right 3rd intercostal space at the costosternal junction, and the

exit wound (6.5 x 4 cm.) in the left 4th intercostal space in the mid-axillary line. The fragment severed the left intercostal and the internal mammary arteries. The left lower and right middle lobes were contused and massive hemopericardium and left hemothorax were present. The right ventricle and auricle were lacerated, but the pericardial sac was intact.



CASE 35

CASE 35 [redacted], was standing in a covered pillbox when struck by a fragment of a Japanese mortar shell which came through the peep slit. The shell burst on the ground at 25 yards distance. He was killed instantly at 2000 hours, 23 March 1944.

Examination revealed a penetrating wound of entry (2.5 cms. in diameter) in the right chest in the 2nd intercostal space, anterior axillary line. The fragment in its course fractured the 2nd rib, perforated the right upper lobe, partially severed the thoracic aorta, perforated the lower lobe, fractured the 8th rib and lodged in the subcutaneous tissues over the 9th rib in the right mid scapular line. Massive hemothorax was present.

The photograph shows the recovered fragment.



CASE 36



CASE 36

UNCLASSIFIED

CASE 36

[redacted] 129th Inf., 37th Div., was killed in action in the 129th sector at 2140 hours, 25 March 1944. He was struck by fragments of a Japanese mortar. Other circumstances are not known.

Examination revealed a large entrance wound (12.5 x 10 cm.) on the left extending from the nipple to the mid-axillary line and from the level of the 3rd to the 6th rib. The fragments shattered the 5th and 6th ribs creating an opening (4 cm. in diameter) into the left pleural cavity. Bone fragments were driven into the left lower lobe producing an irregular laceration. A small metal fragment penetrated the left dome of the diaphragm, and a button from the soldier's jacket was found in the omentum. A lacerated wound 3.2 x 3 cm. was found in the left ventricle. The 7th and 9th ribs posteriorly were fractured, and in the subcutaneous tissue in this region 5 metal fragments were found. Massive left hemothorax was present.

The photographs show the extensive chest wound and the recovered metal fragments.

CASE 37

[redacted] 148th Inf., [redacted] on April 1 1944 having been struck in the arm by a Japanese .25 caliber bullet fired from a distance of 7 yards, walked back toward the first aid station. Enroute he was mistaken for the enemy and was struck in the chest with a .30 caliber bullet fired from a U.S. M-1 rifle from a distance of 30 yards. He was killed instantly.

Examination revealed a perforating wound of the right thorax and a wound of the right shoulder. The entrance wound in the chest (0.5 cm. in diameter) was located in the first intercostal space in the mid clavicular line, and the exit wound (2.5 cm. in diameter) at the level of the 12th rib in the mid scapular line. The bullet perforated the upper and lower lobes of the right lung and fractured the tenth and eleventh ribs. Massive hemothorax was present. The penetrating wound of the left shoulder (.5 cm. in diameter) involved only the left deltoid muscle. No foreign body was found.

CASE 38

[redacted] 1st Bn., FIR (Fijian), while on patrol was kneeling behind a rotten log, when struck by a .25 caliber Japanese bullet fired from a distance of 5 yards. He was killed instantly at 1545, on 31 March 1944.

The entrance wound (.5 cm. in diameter) was found over the sternum at the junction of the manubrium with the body and the exit wound (1.2 cm. in diameter) in the left 8th intercostal space in the anterior axillary line. In its course the bullet fractured the sternum, perforated the aorta, pulmonary artery and left lower lobe, and fractured the 8th rib in making its exit. Massive bilateral hemothorax was present.

[redacted]



CASE 38

Photograph shows the laceration of the pulmonary artery.



CASE 39

CASE 39

[redacted], 129th Inf., while attacking a Japanese pillbox was killed instantly by the point blank explosion of a Japanese hand grenade at 0800 hours, 24 March 1944.

Examination revealed multiple penetrating wounds of the chest, head, face and abdomen. One fragment entering the thorax through the 3rd right intercostal space in the nipple line, had lacerated and lodged in the right upper lobe. A massive hemothorax was present. The 12th dorsal vertebra, the mandible and temporal bones were fractured.

The recovered fragments are shown in the photograph.



CASE 40

[redacted], 184th Inf., while walking through the jungle on patrol was struck by .25 caliber Japanese bullets fired from a distance of 5 yards. He was killed instantly at 1130 hours, 29 March 1944.

Examination of the chest revealed an entrance wound (1.8 cm. in diameter) in the posterior left chest in the 7th intercostal space and an exit wound (3.8 cm. in diameter) in the left mid-clavicle. In its course the bullet had fractured the 4th, 5th, 6th, 7th, and 8th ribs in the axillary line, severely lacerated both lobes and fractured the clavicle at

its exit. Massive left hemothorax was present. Another bullet had penetrated the soft tissues of the left thigh, making its entrance through the lateral side of the upper third. It was found in the vastus medialis. A third bullet perforated the left foot through the first metatarso-phalangeal joint.

In one photograph the tract of the missile is demonstrated by a catheter. The other photograph shows the bullet recovered from the thigh.



CASE 40

CASE 41

[redacted] while kneeling in the open administering first aid to a casualty was struck by a .25 caliber bullet fired by a sniper from a distance of 35 yards. He was killed instantly at 1300 hours, 24 March 1944.

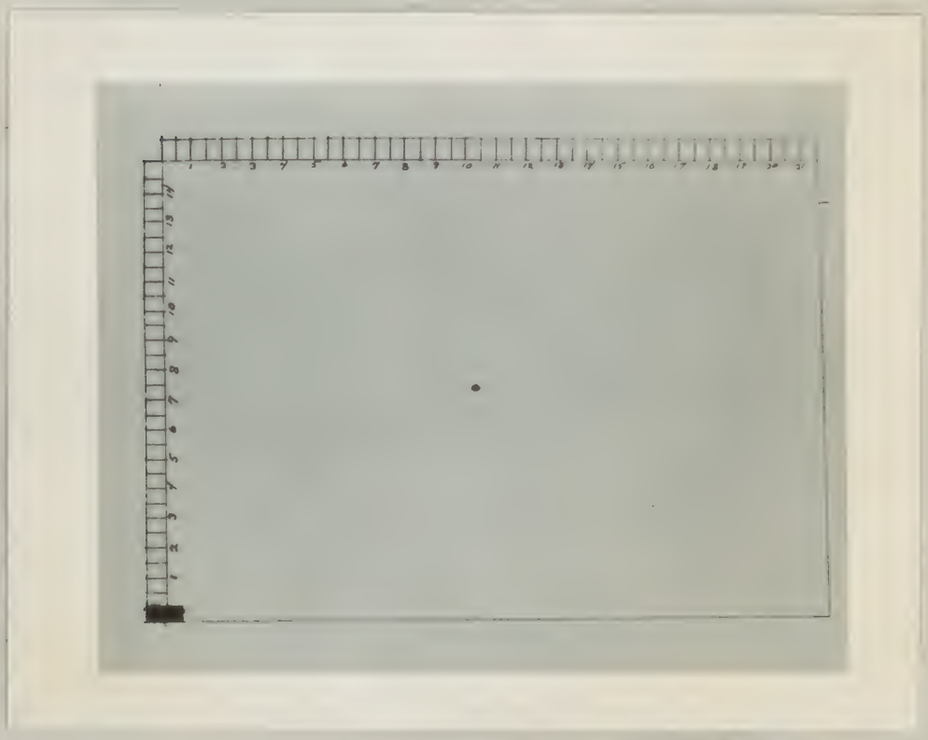
Examination revealed a perforating wound of the left chest. The entrance wound (0.5 cm. in diameter) lay over the 3rd rib anteriorly 4 cms. from the mid line, and the exit wound (1.5 x 1 cm.) over the angle of the left scapula. In its course the missile fractured the 3rd rib and lacerated the hilum of the left lung severing a large branch of the pulmonary artery and a secondary bronchus. The upper left lobe was severely lacerated. Hemothorax (1500 cc.) was present on the left. Blood exuded from the mouth.

CASE 42

[redacted] 129th Inf., [redacted] while squatting in a shallow hole on patrol was struck by a fragment of a U.S. artillery shell which burst on the ground 5 yards distant. He was killed instantly, 1230 hours 29 March 1944.

Examination revealed a penetrating wound of the right chest. The wound of entrance (3.7 cm. in diameter) was situated in the 3rd right intercostal space in the mid axillary line. The fragment fractured the 4th rib, perforated the right middle lobe, the right auricle, the right ventricle and lodged in the left lower lobe. Hemopericardium and massive right hemothorax were present.

The photograph shows the only fragment recovered.



CASE 42

CASE 43

[redacted] 129th Inf., [redacted], was killed in action in the 129th sector. He was struck by .25 caliber Japanese bullets and killed instantly at 1345 hours, 24 March 1944.

The thoracic entrance wound (0.5 cm. in diameter) was found in the 6th right intercostal space in the posterior axillary line, and the exit wound in the 8th left intercostal space in the mid scapular line. The bullet produced fractures of



CASE 43

the right 6th, 7th and 8th ribs, severe lacerations of the posterior surface of the middle and posterior right lobes, fractures of the bodies of the 7th and 8th vertebrae, transection of the spinal cord, perforation of the left lower lobe and fracture of the left 8th rib in the posterior axillary line. A metal fragment 1.2 x 1 x 0.2 cms. was recovered in this region. Massive bilateral hemothorax was present. A severe comminuted fracture of the middle third of the right femur had resulted from another bullet. The wound of entrance on the thigh was very small.

The photograph shows the flattened bullet which was recovered from the thoracic wall.

CASE 44

[redacted] FIR (Fijian), while on patrol, kneeling behind a tree and firing at the enemy, was struck by a .25 caliber Japanese bullet fired from a distance of 20 yards. He was killed instantly on 31 March 1944.

The wound of entrance (.5 cm. in diameter) was located in the left 4th intercostal space in the parasternal line, and the exit wound (3.7 cm. in diameter) in the left 6th intercostal space in the mid-axillary line. The bullet produced irregular lacerations of the right and left ventricles and perforated the upper lobe of the left lung. Massive hemothorax and hemopericardium were present.

In the photograph the perforations in the heart are demonstrated by a catheter lying in the wound tract.



CASE 44



CASE 45

CASE 45

[redacted], 129th Inf., stepped out of his pillbox and was struck by a .25 caliber Japanese sniper bullet from a distance of 25 yards. He fell back into the pillbox and died instantly at 0730 hours, 25 March 1944.

Examination revealed a penetrating wound of the left anterior chest wall. The entrance wound (1 cm. in diameter) was found in the 4th intercostal space at the costochondral junction. Demonstrated at autopsy were: a fracture of the 4th rib and sternum, right hemothorax (3000 cc), perforation of the right auricle and ventricle and a laceration of the hilus of the right lung.

The photograph shows the flattened .25 caliber bullet which was found lying free in the right pleural cavity.



CASE 46

[redacted] 129th Inf., [redacted], while sitting in the cleared open jungle was struck by fragments of a 90 mm Japanese shell which exploded on the ground at a distance of 20 yards. He was killed instantly at 1425 hours, 25 March 1944.

Examination disclosed an exit wound (2 cm. in diameter) on the left arm 6 cms. below the acromion process and an entrance

[redacted]



CASE 46



CASE 46



CASE 46

wound (20 x 10 cms.) over the left scapula. The head of the left humerus shattered and the tract widened by an explosive force which fractured the 3rd, 4th, 5th, 6th, 7th and 8th ribs in the mid axillary line, and the 5th, 6th and 7th ribs in the anterior axillary line. The parietal pleura was torn, both lobes of the left lung were severely lacerated, and the left scapula was extensively comminuted. A hemothorax (3500 cc.) was present.

Photographs show the large wound of entry, and a small wound of exit of one of the fragments. The extensive damage to the left thoracic cage is evident. Several small metal fragments recovered from the scapular area are shown.

CASE 47

[redacted] New Zealand, while walking through the jungle on patrol was struck by a .25 caliber Japanese sniper bullet fired from a distance of 30 yards. He was killed instantly at 0930 hours on 14 March 1944.

Examination revealed a perforating wound of the neck with the entrance (0.6 cm. in diameter) situated below the tip of the left mastoid and the exit (4.3 cm. in diameter) below the right acromioclavicular articulation. In its oblique course the bullet perforated the 3rd cervical vertebra, severed the spinal cord, fractured the 1st, 2nd, and 3rd ribs at their costovertebral junctions, entered the pleural cavity, perforated the upper lobe of the right lung and made its exit between the clavicle and scapula. Present on the right was a hemothorax of 2000 cc.

SECRET



CASE 48

CASE 48

[redacted] PIR,(Fijian), while moving forward on patrol in a crouched position was struck by a fragment of a 90 mm. Japanese mortar shell, which burst on the ground 10 yards away. He died enroute to the hospital at 1000 hours, 26 March 1944.

Examination revealed a penetrating wound of the right posterior chest. The fragment entered 8 cm. from the mid-line at the level of the 6th dorsal vertebra through a wound 1.5 cm. in diameter. It coursed under the skin to enter the left chest in the 6th intercostal space 5 cm. from the mid-line. The 7th rib was fractured at this point. The posterior surface of the left lower lobe was severely lacerated. A metal fragment was recovered from the pleural cavity. A left hemothorax (2000 cc.) was present.

Photograph shows the recovered missile.

CASE 49

[redacted] 129th Inf., while walking behind a tank was struck twice by .25 caliber Japanese bullets fired from a distance of 40 yards. He was killed instantly at 1030 hours, 24 March 1944.

Examination revealed two penetrating wounds of entry (4 x 2.4 cm. and 3.5 x 2 cm. in diameter) one through the right, the other through the left second costosternal junction. Postmortem examination showed: compound comminuted fractures of the second ribs (right and left) and sternum, severance

of the right intercostal and internal mannary arteries, bilateral hemothorax, complete transection of the aortic arch and right pulmonary artery and vein, perforation of the left auricle, laceration of the right upper lobe, incomplete division of the esophagus and trachea at the level of bifurcation and perforation of the body of the 7th thoracic vertebra.

CASE 50

[redacted], 129th Inf., [redacted] was prone in the open behind a tank assault when struck by a .25 caliber Japanese bullet fired from a distance of 100 yards. He was wounded at 1100 hours 24 March 1944. Several hours later thoracotomy was performed at the 21st Evacuation Hospital and a lacerated left lung was sutured. He received penicillin daily and seemed to improve. Death from pulmonary embolus occurred suddenly at 0730 hours, 28 March 1944.

Examination revealed a curved incision (22.5 cm. in length) in the left posterior chest wall extending from 5th dorsal vertebra to the axillary line. A left fibrinous pleuritis with effusion (500 cc.) was present. A laceration of the left lower lobe had been closed by suture. The lung was congested and a thrombus was found lodged in the pulmonary artery.

CASE 51

[redacted] 129th Inf., [redacted], while standing in an open foxhole received a mortal wound at 1500 hours 27 March 1944 from a fragment of a U.S. 4.2 mortar shell which burst on the ground 3 yards away. At the portable surgical hospital the sucking wound of the chest was closed. The following day he was transferred to the 21st Evacuation Hospital. Upon admission to the ward dehiscence of the wound was present. A second operation was done at which time bone fragments were removed from the lung and bleeding was controlled. The patient never regained consciousness and died at 1700 hours 30 March 1944.

Autopsy revealed an oblique operative incision 17.5 cm. long, extending from the 3rd dorsal spine to the 9th rib, in the right posterior chest. The right scapula, 7th and 8th ribs were fractured. A right hemothorax was found and sutures were present in the right middle and lower lobes. The lungs were emphysematous, and there was marked dilatation of the right ventricle. Death was attributed to heart failure. In this case death may have been precipitated by the rapid administration of necessary intravenous fluids in the presence of some pulmonary obstruction.

CASE 52

[redacted], 129th Inf., while walking in a crouched position following a tank assault, was struck by a .25 caliber Japanese bullet fired from a distance of 25 yards. He was wounded at 1245 hours, 24 March 1944, and died 24 hours later. Death resulted from transection of the thoracic spinal cord and was associated with terminal hyperthermia.

The wound of entrance (3 cm. in diameter) was located in the center of the left supraclavicular region. The bullet entered the chest through the first intercostal space, fractured the first and second ribs and produced a gutter wound in the left upper lobe. The body of the second dorsal vertebra was fractured and the spinal cord severed at the same level. A massive left hemothorax was found. The bullet was not recovered.

CASE 53

[redacted], 13th AAF, shot himself with a .30 caliber carbine at 1300 hours, 4 April 1944. He arrived at the hospital in ten minutes, was given 3 units of plasma and underwent immediate thoracotomy. An attempt was made to suture the lacerations of the lung but the patient died on the table from shock due to hemorrhage.

Postmortem examination revealed a perforating entry wound 6mm. in diameter in the anterior left chest, 10 cm. from the mid line in the 7th intercostal space. The wound of exit, located posteriorly in the 3rd intercostal space 5 cm. from the mid line, was 2.5 cm. in diameter. The bullet in its course lacerated the left lower lobe. A contusion of the left ventricle and a hemothorax (1000 cc.) were found.

CASE 54

[redacted], 3rd Bn., 129th Inf., while prone firing at the enemy was hit twice by .25 caliber bullets fired from a Japanese machine gun from a distance of 35 yards. He was wounded at 0830 hours on the 24 March 1944 and taken to the hospital immediately. After adequate shock therapy the chest wound was debrided and closed and laporotomy performed. [redacted] died at 0930 hours, 28 March 1944 of pulmonary edema.

Postmortem examination revealed two wound tracts. One bullet produced an entry wound (3.2 x 2.5 cm.) lateral to the spinous process of the first lumbar vertebra, this missile coursed superiorly and laterally, fractured the 12th rib, perforated the diaphragm, and was found lodged under the 11th rib in the mid axillary line. The other wound was perforating in type with its entrance (1.2 cm. in diameter) located 1 cm. below the right clavicle at the outer third and exit (17.9 cm. in length) located 9 cm. to the left of the 11th dorsal vertebra. In its course this bullet produced a blast injury of the right lung, perforated the left lower lobe and fractured the 9th rib. Edema of the left lower lobe, fibrinous pleurite and hemo-pneumothorax were present. The right lung was

diffusely discolored from blast injury. The abdominal examination was negative, as the bullet had traversed the retroperitoneal space.

CASE 55

[redacted] 145th Inf., while kneeling in the open firing at the enemy was struck by a .25 caliber Japanese bullet fired from a distance of 15 yards. He was wounded on 16 March 1944. Thoracotomy was performed at the 21st Evacuation Hospital several hours later. The right lower lobe was removed, the diaphragm closed and bleeding from the perforation in the body of the 12th dorsal vertebra was controlled by electrocoagulation. The spinal cord was severed at the level of 12th dorsal. The patient was evacuated from the island on the 8th postoperative day. He developed an empyema at the 31st General Hospital. Surgical drainage of the empyema was established. In spite of adequate drainage, penicillin and supportive therapy, the patient died from the infection on 25 April 1944.

Postmortem examination revealed gross infection of the right pleural cavity. The remaining upper and middle lobes were shrunken and adherent and the pleura markedly thickened. The right lower bronchus communicated with the pleural cavity. The spinal cord was transected at the level of the fracture of the 12th dorsal vertebra. The diaphragm had been repaired. Generalized intestinal distension and focal necrosis of the liver were present.

CASE 56

[redacted] 1st Bn., FIR, while crouching and advancing on patrol was shot through the left chest by a .25 caliber Japanese bullet from a distance of 30 yards. He was wounded in the morning, 30 March 1944. Upon arrival at the Hospital immediate thoracotomy was performed in an attempt to control pulmonary bleeding. The patient died several hours later (1420 hours, 30 March 1944) of acute cardiac dilatation and hemorrhage. The cardiac dilatation was thought to be secondary to obstruction of the pulmonary circulation (See Case 51).

Postmortem examination showed a wound of entry (1.2 cm. in diameter) through the 2nd left intercostal space above the costosternal junction. The wound of exit had been closed at the time of operation. A curved anterio-lateral incision from the 2nd to 6th rib was noted. Lacerations of the upper and lower lobes had been sutured. The right heart was markedly dilated. Moderate left hemothorax was present.

CASE 57

[redacted] 920th ABS, while stepping out of a truck was hit by fragments of a Japanese artillery shell which burst on the ground 2 yards away. He was wounded at 0600 hours, 24 March 1944. At operation within an hour at the field hospital the left chest wound was excised, the lung sutured and the chest closed. In addition a loop

[redacted]



CASE 57

colostomy of the sigmoid was done because of a perforation of the colon. The patient died several hours later from massive pulmonary hemorrhage.

Examination revealed penetrating wounds of the chest and left gluteal region. The entry wound in the anterior left chest through the 5th interspace had been excised and closed. The 5th and 6th ribs were fractured. Massive hemothorax was present. A large mattress suture partially closed the laceration in the left lower lobe. The abdominal cavity had been entered by a fragment which perforated the left wing of the ilium leaving a wound of entrance 7.5 cm. in diameter. Fragments of bone had been dispersed extensively lacerating the gluteal muscles. As stated above the perforation of the sigmoid colon had been treated by exteriorization through a left rectus incision.

Photograph shows metal fragments removed from the chest wall.

CASE 58

[redacted], 182nd Inf., while crawling through the jungle on patrol was struck by .25 caliber Japanese machine gun bullets. He was wounded at 2100 hours, 2 May 1944, and reached the hospital within three hours. Thoracotomy was decided upon because of intrathoracic bleeding. [redacted] died on the operating table during induction of the anesthetic at 0515 hours, 3 May 1944.

Examination revealed a perforating wound of the left chest and a penetrating wound of the right axilla. One entrance wound (1.2 cm. in diameter) into the chest was situated in the left midscapular region and the exit wound (5 x 2 cm.) in the left supraclavicular fossa. In its course the bullet fractured the scapula, and the 2nd, 3rd and 4th ribs. The

broken ribs had severely lacerated the pleura and the upper left lobe. The bullet had not entered the pleural cavity. A massive left hemothorax was present. Another bullet penetrated the apex of the right axilla through a wound 3.7 cm. in diameter, and in its course severed the radial and median nerves and fractured the upper third of the humerus. The bullet was found in the belly of the triceps muscle.



CASE 59

CASE 59

[redacted] 24th Inf., while running forward in a skirmish line was struck by .25 caliber Japanese machine gun bullets fired from a distance of 75 yards. He was killed instantly at 1100 hours, 14 April 1944.

Examination revealed multiple wounds. A missile which produced a penetrating wound of the right side of the abdomen and traversed the right thorax was responsible for rapid death. This bullet entered the right kidney region opposite the spinous process of the 2nd lumbar vertebra. In its course it lacerated the lower pole of the right kidney, perforated the hepatic flexure of the colon, right lobe of the liver and diaphragm, lacerated the lower right lobe of the lung and fractured the 8th, 9th, 10th, 11th and 12th ribs in the posterior axillary line. Hemoperitoneum and a right hemothorax (1000 cc.) were present. The bullet was recovered in the subcutaneous tissue. Another bullet perforating the neck entered the right side in the posterior cervical

[redacted]



CASE 59

triangle and made its exit below the tip of the left mastoid process. The trachea was severed at the level of the cricoid cartilege. Another bullet struck the left side of the face producing a gutter wound 12.5 x 3.7 x .25 cm., which destroyed the left temperomandibular joint. Present also was a perforating wound in the right infraclavicular space with fracture of the right clavicle.

One photograph reveals the gutter wound of the face below which is the wound of exit. The other photograph shows the distorted bullet and a part of the jacket removed from the right chest wall.

CASE 60

[redacted] 129th Inf., while crouching following a tank assault was shot by a .25 caliber Japanese machine gun bullet from a distance of 25 yards. He was killed instantly at 0800 hours, 13 March 1944.

Examination showed an entrance wound (0.6 cm. in diameter) through the right anterior chest 2nd intercostal space in the nipple line, and an exit wound (7.5 cm. in diameter) through the left loin above the wing of the ilium. In its oblique course the bullet perforated or severed the right middle lobe of the lung, the diaphragm, the right lobe of the liver, the pancreas at the junction of the head and body, the transverse duodenum, the jejunum, and the left colon at the sigmoid junction. Moderate hemothorax and hemoperitoneum were present.



CASE 61

CASE 61

[redacted] 129th Inf., while standing in a foxhole covered by light roofing was killed instantly by the direct burst of a Japanese mortar shell. 4 other men were wounded. [redacted] was killed at 0530 hours, 24 March 1944.

Multiple penetrating wounds of the back, chest and abdomen were sustained. A large chest wound caused death. The wound of entrance was 9 cm. in diameter and situated in the posterior left chest 2.5 cm. from the spinous processes of T-11 and T-12. In its course this fragment fractured the 5th, 6th ribs anteriorly, and the 8th, 9th and 10th ribs posteriorly, fragmented the left lower lobe of the lung, perforated the diaphragm, disrupted the spleen, and transected the descending colon. The bodies of the 11th and 12th dorsal vertebrae were badly comminuted. Massive left hemothorax and hemoperitoneum were present.

The photograph shows metal fragments identified as parts of a first aid box which were recovered.

CASE 62

[redacted], 129th Inf., while in a pillbox was surrounded by Japanese. He was killed by fragments of a Japanese hand grenade which exploded at point blank range. 2 other men in the pillbox were wounded. Harmon died instantly at 0800 hours, 24 March, 1944.



CASE 62

Examination revealed multiple penetrating wounds of the chest, right thigh, right leg and right arm. The wounds of the thorax were fatal. There were multiple small penetrating wounds through the right posterior axillary line from the 7th to 12th rib. The largest was 1.2 cm. in diameter. Small fragments perforated the lower lobe of the right lung and diaphragm, and produced a laceration (7 x 3 x 1.3 cm.) in the dome of the liver 7 x 3 x 1.3 cm. Massive right hemothorax and moderate hemoperitoneum were present. The remaining wounds were not extensive.

Photograph shows the recovered grenade fragments.

CASE 63

[redacted], 1st Bn., FIR, while running on patrol stepped on a U.S. land mine and was killed instantly at 1100 hours, 26 March 1944.

Examination revealed 9 penetrating wounds. 3 fragments entered the left chest anteriorly in the 1st intercostal space in the nipple line and perforated or severed the upper left lobe, pulmonary artery, aortic arch, trachea, right lower lobe, diaphragm and liver. 2 metallic fragments were found in the liver. Hemothorax (left 2500 cc. and right 250 cc.) was present. In addition there were wounds of the left elbow, thigh, cheek, chin and eye, and an extensive gutter wound of the left buttock.

Photograph shows metal fragments removed from the liver.

[redacted]



CASE 63



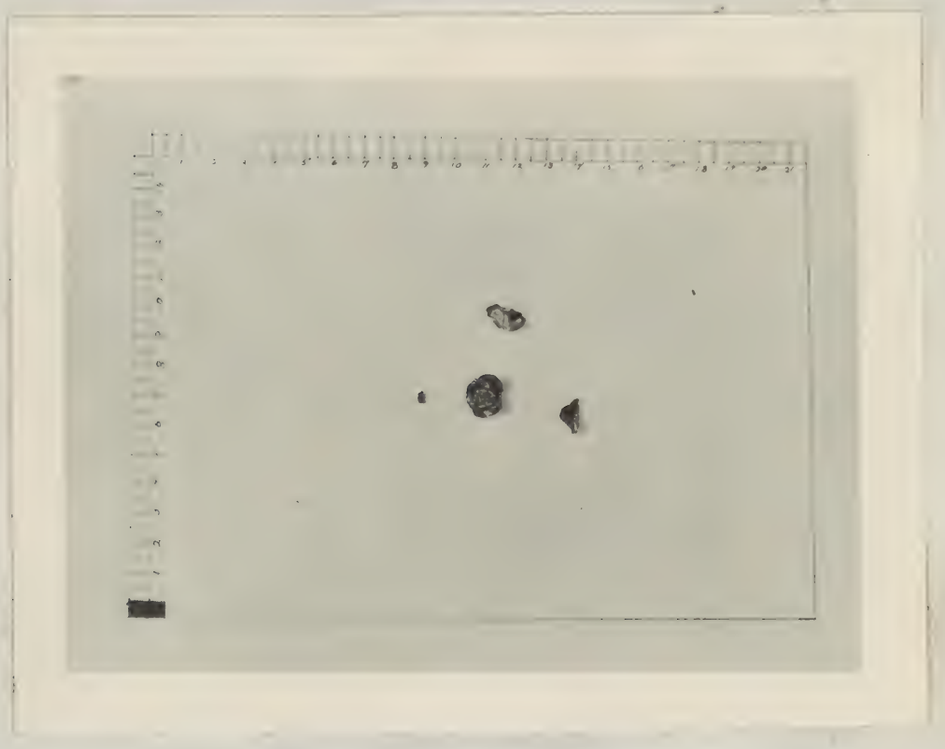
CASE 64

CASE 64

[redacted] 21st Rcn.Tr., was killed by a U.S. hand grenade which exploded in his pocket while returning from patrol. He was killed instantly at 0920 hours, 25 April 1944.

Examination revealed 12 penetrating wounds, 4 of which penetrated the thorax. These fragments entered the left chest in the mid-axillary line at the levels of the 4th, 6th and 9th ribs. The left 4th, 5th and 6th ribs were fractured, the diaphragm, spleen, and pancreas were lacerated, and the stomach was perforated in 2 places. Massive left hemothorax and hemoperitoneum were present. 1 grenade fragment was recovered from the pleural cavity and 2 fragments from the lumen of the stomach. The remaining wounds were in the upper extremities.

The photograph shows the recovered fragments, the largest of which was removed from the thorax.



CASE 65

CASE 65
(UNKNOWN JAPANESE SOLDIER). This soldier was killed 22 March 1944 by fragments from a high explosive shell.

Examination revealed an entrance wound (2 cm. in diameter) in the 11th left intercostal space. The fragments in

their course lacerated the lower lobe of the left lung, diaphragm and spleen, and were found in the subcutaneous tissue at the exit wound. Present also was a bilateral hemothorax and a hemoperitoneum (300 cc.)

The photograph shows the small metal fragments recovered from the wound tract.

CASE 66

[redacted], 21st Hen., while crouching and moving forward in a skirmish line was struck 3 times by .25 caliber Japanese machine gun bullets fired from a distance of 20 yards. He was killed instantly at 1600 hours, 27 March 1944.

An abdominal wound was responsible for death. The wound of entrance (.5 cm. in diameter) was placed in the mid line 7.5 cm. above the umbilicus. This bullet severed the abdominal aorta and fractured the first lumbar vertebra. Another bullet perforated the right deltoid muscle and entered the right thoracic cavity through the 4th intercostal space in the anterior axillary line. The 5th, 6th and 7th ribs were fractured, the lower lobe of the lung and the dome of the diaphragm were lacerated, the liver was perforated, and the right kidney was fragmented. There were also superficial wounds of the left hip and left forearm.

CASE 67

[redacted] 129th Inf., was struck by a .25 caliber Japanese bullet fired by a sniper from a distance of 25 yards. His position when hit was not known. He was killed instantly at 1300 hours, 24 March 1944.

The bullet entered the left thorax through a wound (.5 cm. in diameter) in the anterior 4th intercostal space in the anterior axillary line, and made its exit through a wound (2.5 x 1.5 cm.) in the right 6th intercostal space in the mid-axillary line. The bullet in its course perforated the upper left lobe, left ventricle, right ventricle, right lower lobe, the diaphragm, and produced an irregular laceration in the vertex of the liver 7.5 cm. in length before making its exit. Massive bilateral hemothorax and hematoperitoneum were found.

CASE 68

[redacted], 132nd Inf., while on patrol entering a Japanese pillbox was struck by a .25 caliber Japanese bullet fired at close range. He was wounded at 1700 hours, 29 March 1944. Laporotomy was performed several hours later at the clearing station. At operation the left diaphragm was repaired and a transverse colostomy was performed after suture of a perforation in the splenic flexure of the colon. The patient died at 0600 hours, 4 April 1944, with signs of cardio-respiratory failure.

Examination revealed a penetrating bullet wound of the left chest entering the 6th intercostal space in the posterior axillary line. Transverse colostomy had been performed through an upper left rectus incision. The 7th, 8th and 9th ribs were fractured, and moderate left hemothorax was present. The left lower lobe was discolored from blast injury. The pericardial sac contained a small amount of blood although it had not been perforated. An area of epicardial ecchymosis was found on the left ventricle. Present also was a laceration of the spleen and an explosive wound of the left kidney with a large hematoma. A perforation in the splenic flexure of the colon had been sutured. The repair of the diaphragm was unsuccessful.

CASE 69

[redacted], 129th Inf., while leading his platoon against the enemy was struck by a .25 caliber bullet fired from a short distance. He was wounded at 0900 hours, 13 March 1944. An hour later debridement and closure of the chest wound was done at the 21st Evacuation Hospital. He was evacuated by air on 15 March and died on 21 March 1944 at the 9th Station Hospital of secondary hemorrhages from the left lung and spleen.

Postmortem examination revealed a perforated wound of the left elbow and a compound fracture of the humerus. The same bullet had entered the left chest in the 6th intercostal space in the posterior axillary line and made its exit in the left 7th intercostal space. The thoracotomy incision was well healed. The left pleural cavity contained a liter of blood. Both lobes of the left lung were lacerated and the diaphragm, spleen, and kidney were perforated. Old and fresh blood were present in the peritoneal cavity. A retroperitoneal hematoma was well organized.

CASE 70

[redacted], 1st Bn., FIR, while crouching in a skirmish line on patrol was struck by fragments of a Japanese mortar shell which burst on the ground 20 yards distant. He was wounded on 29 March 1944. Splenectomy, exteriorization of the colon, closure of a chest wound and debridement of an arm wound were performed the same day. He died at 2215 hours, 30 March 1944 of shock and hemorrhage.

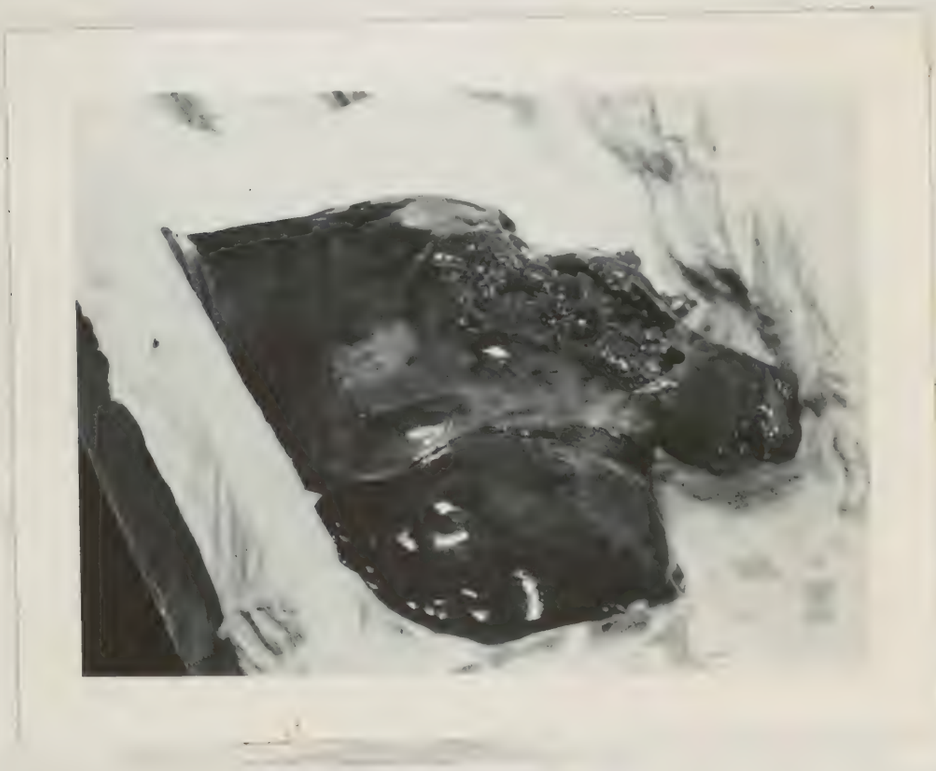
Examination revealed wounds of the chest, abdomen and left arm. A linear incision extended in the 9th, left intercostal space from the nipple to the axillary line. The pleural cavity contained 3000 cc. of blood. Fibrinous pleuritis, congestion of the lung and dilatation of the right heart were found. The rent in the left diaphragm was incompletely closed. A left rectus incision was present through which protruded the exteriorized loop of the perforated transverse colon. A small amount of free blood was present in the abdominal cavity. The spleen had been removed. The body and tail of the pancreas were lacerated. An explosive wound of the left kidney and a large retroperitoneal hematoma were found. Present also in the lower third of the left arm was the wound of a severe compound comminuted fracture of the humerus.

[redacted]

CASE 71

[redacted], 37th Rcn. Tr., while walking in a crouched position through thick jungle on patrol was struck in the left lumbar region by a Japanese .25 caliber bullet fired from a distance of 25 yards. He was wounded at 1700 hours, 4 March 1944. Laporotomy was performed at the 21st Evacuation Hospital several hours later. Perforations in the bowel were sutured and an attempt was made to arrest hemorrhage from a laceration in the liver. He died 1615 hours, 5 March 1944 from shock and hemorrhage.

Examination revealed a wound of entry (0.5 cm. in diameter) in the left lumbar region directly below the 12th rib and an exit wound (1 cm. in diameter) through the right mid-axillary line in the 8th intercostal space. In its course, the bullet perforated jejunum, ileum, transverse colon, liver, diaphragm and the lower right lobe of the lung and fractured the right 9th rib. Moderate hemoperitoneum and hemothorax (right) were present.



CASE 72

CASE 72 [redacted] 3rd Bn., FIR (Fijian), while standing in the jungle was mistaken for the enemy and shot by a fellow soldier 30 yards distant with a Bren machine gun. He was wounded at 1530 hours, 1 April 1944. At the 21st Evacuation Hospital after shock therapy right pulmonary lobectomy was performed, and a wound in the liver was tamponaded. He died of hemorrhage at 2030 hours, 1 April 1944.

[redacted]

RESTRICTED

There were two perforating wounds of the right chest. The wounds of entry (each .5 cm. in diameter) were both situated in the 6th intercostal spaces 2.5 and 3.7 cm. respectively from the mid-line, and the exit wounds were in the 8th intercostal space in the mid-axillary line. The 9th rib was fractured. A recent anterio-lateral 6th intercostal space incision was present. The lower right pulmonary lobe had been removed and the rent in the diaphragm incompletely closed. A large explosive wound occupied the dome of the right lobe of the liver.

Photograph shows the extensive liver wound.

CASE 73

[redacted], 24th Inf., while lying prone in the jungle on patrol was struck by Japanese .30 caliber machine gun bullets fired from a distance of 30 yards. At 1000 hours, 19 April, received shock treatment followed by right thoracotomy. At operation a bullet and a bone fragment were removed from the right lung and the diaphragm and lung were sutured. This soldier did not recover from shock and died at 2150 hours, 19 April 1944.

Examination revealed 2 major wounds. One bullet produced a perforating wound of the right thigh and a compound fracture of the femur. The other bullet penetrated the left buttock and coursed superioraly to the right, terminating in the right pleural cavity. This bullet fractured the 5th lumbar vertebra, severed the cauda equina, lacerated the right kidney, perforated the diaphragm and lower lobe of the right lung. In addition there were superficial gutter wounds of the right and left forearms.

CASE 74

[redacted], 3rd Bn., 145, while walking along a jungle trail was struck by a fragment of a Japanese mortar shell, which burst on the ground 15 yards away. He was wounded at 1930 hours on 18 March 1944. After arriving at the hospital within one hour continuous shock therapy was instituted. Thoracotomy was performed at 0200, 19 March 1944, in an attempt to arrest hemorrhage. The patient died 2 hours later of shock from hemorrhage.

Examination revealed a sutured wound over the posterior lower left chest 10 cm. in length. A laceration in the left lower pulmonary lobe had been sutured. The diaphragm, stomach, and spleen were lacerated. A moderate left hemothorax and hemoperitoneum (2500 cc.) were present.

CASE 75

[redacted] Anti-Tank, 35th Inf., at 2230 hours, 2 April 1944, left his foxhole to void. On return was shot through the abdomen by an apprehensive bunk mate with a U.S. 45 caliber revolver from a distance of 2 yards. He died within an hour.

RESTRICTED

SECRET

Examination revealed a penetrating wound (1.5 cm. in diameter) in the upper right quadrant of the abdomen. The peritoneal cavity was filled with blood from a perforation of the vena cava. In addition several loops of jejunum had been perforated.

CASE 76

[redacted], 145th Inf., while standing in the open was struck by fragments of a Japanese 90 mm. mortar shell which burst on the ground 2 yards distant. He was killed instantly 18 March 1944.

Apparently a fragment had struck the abdominal wall tangentially in the midline, .5 cm. above the symphysis. A loop of ileum was protruding. Only remnants of the urinary bladder remained. The right ilium, right pubic ramus, and sacrum were severely comminuted. The peritoneal cavity contained two liters of blood.

CASE 77

[redacted], PFC, while crouching on patrol was struck in the right lumbar region by a .25 caliber Japanese bullet fired from a distance of 20 yards. He was shot at 1030 hours, 29 March 1944 and died one hour later in the aid station from internal hemorrhage.

Examination revealed a perforating wound of the right lumbar region. The entrance wound (0.5 cm. in diameter) was located in the right lumbar region 3 cm. above the posterior superior spine of ilium and the exit wound (0.6 cm. in diameter) on the left buttock on a level with the greater trochanter of the femur. The bullet in its course fractured the wing of the right ilium, severed the right spermatic and pudendal arteries and rectum and fractured the sacrum. Massive hemoperitoneum was present.

CASE 78

[redacted] Med.Dept., 129th Inf., while lying prone beside his medical officer, was struck by a .25 caliber Japanese bullet fired from the rear at a distance of 75 yards. He spoke a few words, had several convulsive seizures, and died at 1100 hours, 24 March 1944.

Examination revealed a perforating wound of entrance (.5 cm. in diameter) over the right 12th rib in the posterior axillary line and an exit wound (10 x 0.5 cm.) through the left lumbar region at the level of the 5th spinous process, 15 cm. from the mid line. In its oblique course the bullet fractured the 12th rib, exploded the right kidney, lacerated the right lobe of the liver and mesenteric border of the mid portion of the transverse colon, and fractured the body of the first lumbar vertebra. Massive hemoperitoneum was present.

[redacted] RESTRICTED

CASE 79

[redacted] 25th Inf., left his foxhole at night to defecate. While returning to his hole he was shot by a fellow soldier with a .30 caliber U.S. machine gun from a distance of 30 yards. He was killed instantly 1200 hours, 16 April 1944.

One of the two wounds had its entrance (.6 cm. in diameter) over the right scapula and exit (1.2 cm. in diameter) through the left side of the neck. The bullet producing this wound fractured the 3rd cervical vertebra and severed the spinal cord. The other bullet produced a long (32.5 cm.) gutter wound of the right side of the abdomen which resulted in evisceration. This missile pierced the ascending and transverse colon, ileum and liver.

The photograph shows the extent of the gutter wound and the eviscerated bowel.



CASE 79

CASE 80

[redacted] 129th Inf., while running forward over open terrain was shot by a .25 caliber Japanese machine gun from a distance of 30 yards. He was killed instantly 0830 hours, 24 March 1944.

Of the two bullet wounds, one (1 cm. in diameter) was classified as penetrating and was situated 7 cm. superior to the umbilicus in the mid line, the other was a perforating wound with the entry wound (1 cm. in diameter) through the right lower quadrant and the exit wound (4 x 2 cm.)

RESTRICTED

through the right transverse process of the 4th lumbar vertebra. Examination of the abdominal cavity revealed a massive hemoperitoneum, severance of the middle colic artery, linear laceration of the mid portion of the transverse colon, division of the right common iliac vein and artery and a compound fracture of the 4th and 5th lumbar vertebrae.

CASE 81

[redacted] Field Artillery, while assigned to a detail burying the Japanese dead in front of the perimeter wandered away from the main party. He was struck by a .25 caliber bullet which was thought to have been fired by a sniper. He was wounded 1530 hours, 27 March, and arrived at the hospital within 2 hours. Laporotomy was performed and an extensive wound of the liver was found. He died 1830 hours, 27 March 1944, of shock from hemorrhage.

Examination revealed a penetrating wound (.5 cm. in diameter) in the 11th right intercostal space in the anterior axillary line. A recent T-incision was present in the right upper quadrant of the abdomen. The abdominal cavity contained 2 liters of blood. An extensive laceration of the right lobe of the liver had been filled with transplanted muscle. The 12th rib was fractured. Approximately one third of the shattered right kidney remained and bone fragments were found in the remnant of this kidney. There was no wound of exit. No foreign body was recovered.

CASE 82

[redacted], 182nd Inf., while standing in the open was struck by multiple fragments of a Japanese hand grenade which exploded 1 yard away. He was wounded at 1345 hours, 13 March 1944. Abdominal exploration which was performed at the Clearing Station several hours later was reported negative. Multiple penetrating wounds of the left chest wall were debrided at the same time. He was evacuated by air from the island 18 March 1944. Upon arrival at a hospital in the rear echelon on the same day, evisceration was discovered. Secondary wound closure and ileostomy were done. He received penicillin and general supportive treatment, but died at 0835 hours, 25 March 1944 of peritonitis. (It is suggested that air evacuation resulted in evisceration).

Postmortem examination revealed multiple healed wounds involving the left side of the body from the axilla to the knee in a band between the anterior and posterior axillary lines. The abdomen was distended. Incomplete visceral herniation was present below the ileostomy in the partially closed incision. Advanced diffuse suppurative peritonitis was present.

RESTRICTED

CASE 83

[redacted], 132nd Inf., while following a jungle trail was struck by fragments of a 90mm. Japanese mortar shell which burst on the ground 25 yards distance away. He was wounded at 1530 hours, 13 March 1944. Laporotomy was performed at the portable surgical hospital and a rent in the colon sutured. After transfer to the 21st Evacuation Hospital 2 days later, because of severe distension a colostomy was done. He died at 1115 hours, 16 March 1944. Death was attributed to peritonitis.

The wound responsible for death had its entrance at the lower right costal margin and its exit just left of the umbili us. Diffuse peritonitis resulting from leakage from two perforations in the jejunum had been missed at the time of operations, was discovered. In addition penetrating wounds of the left and right thigh and right knee were present.



CASE 84

CASE 84

[redacted], 129th Inf., while standing outside his foxhole was struck by a fragment of a 4.2 U.S. mortar shell. The shell fell short and burst on the ground at 3 yards distance. He was wounded 27 March 1944. One fragment struck the right hip and coursed retroperitoneally.

On 31 March 1944 an ileostomy was performed because of abdominal distention. He died 1 April 1944. Death was attributed to paralytic ileus and unexplained uremia.

The major wound had its entrance (10 x 5 cm.) at the level of the right iliac crest. The fragment producing this wound fractured the ilium and 5th lumbar vertebra, severed the cauda equina, entered the right retroperitoneal space and shattered the lower pole of the right kidney. A metal fragment was recovered in this area. An ileostomy had been performed through a right paramedian incision. The peritoneal cavity contained a small amount of free serous fluid. All coils of intestine were markedly distended. A large hematoma was present in the right kidney area. A penetrating wound of the right shoulder and a perforating wound through the soft tissues of the right arm were observed.

Photograph shows the shell fragment removed from the right renal area.



CASE 85

[redacted] 25th Inf., while on patrol was carrying a grenade in the right hand when it exploded. He was wounded at 1500 hours, 1 April. Laparotomy was performed at the 31st Portable Surgical Hospital at which time several loops of intestine were resected. On the following day he was transferred to the 21st Evacuation

[redacted]

Hospital and died at 2355 hours, 11 April 1944.

Examination revealed 5 penetrating wounds of the anterior left side of the abdomen, varying from 1.8 to 5 cm. in diameter. The peritoneal cavity contained a moderate amount of sanguino-purulent fluid. End to end anastomosis of the upper jejunum and the left splenic flexure of the colon had been performed. Early gangrenous changes were noted in the descending colon. Small multiple lacerations of the spleen, pancreas and left kidney were present. One grenade fragment was recovered from the splenic fossa, another from the lumen of the transverse colon. Present also was a penetrating wound of the right hand with fracture of the 4th metacarpal and 4th proximal phalanx.

Photograph shows the recovered grenade fragments.

CASE 86

[redacted] 145th Inf., while lying in an open foxhole was struck by a fragment of a 500 lb U.S. aerial bomb, which exploded in a tree 5 yards above. The bomb was dropped accidentally by a U.S. plane leaving on a bombing mission on 19 March 1944. The wound was debrided at the portable hospital shortly thereafterwards. He was transferred to the Evacuation Hospital on the following day, and died at 0830 hours, 23 March 1944. Death was attributed to peritonitis.

[redacted] 7.5 cm.) over the crest and wing of the right ilium. This wound was grossly infected. The lamina and spinal process of the 5th lumbar vertebra were destroyed. The retroperitoneal space was filled with purulent exudate. Diffuse fibrino purulent peritonitis had resulted from direct extension of infection from the wound. A small perforating wound of the right shoulder was clean and granulating..



CASE #7

CASE #7

[redacted], Fiji (Fijian), while on patrol was struck in the left groin by a .25 caliber Japanese bullet fired from a distance of 25 yards. Though aid reached him immediately, he died in several minutes at 1615 hours, 29 April 1944.

Examination revealed a penetrating wound of the left groin. The wound of entrance (3.1 cm. in diameter) was located 1 cm. below the middle third of the left inguinal ligament. The femoral artery and vein were severed. The bullet was imbedded in the pelvis.

Photograph below is bullet removed from the deceased.

Declassified

CASE 88

[redacted] 132nd Inf. [redacted] was found in a foxhole at night to void, on returning was mistaken for the enemy and in the resulting confusion was stabbed to death by fellow soldiers. He died within an hour of hemorrhage, on 17 April 1944.

Examination revealed 10 stab wounds in the upper and lower extremities. The right femoral artery was severed in its upper third and the left radial artery was divided. No other important structures were injured.

CASE 89

[redacted] (JAPANESE), [redacted], 132nd Inf., was brought by American soldiers to the aid post and treated for shock. Despite treatment he died in several hours.

Examination revealed a perforating bullet wound of the right thigh. The entrance wound (2.5 cm. in diameter) was found on the lateral surface and the exit wound (2.5 cm. in diameter) on the medial aspect. The right femur was shattered in its middle third. Present also was a perforating bullet wound of the abdominal wall in the right lumbar region with wounds of entrance and exit both 2.5 cm. in diameter. This bullet did not enter the peritoneal cavity.

CASE 90

(UNKNOWN JAPANESE) The body of this soldier was partially decomposed when received. It appeared that the soldier had been wounded by bullets. Death was attributed to shock associated with a severe fracture of the left femur.

Examination revealed a perforating wound of the lower third of the left thigh. The wound of entrance (.5 cm. in diameter) was medial and the explosive wound of exit (16.6 x 13.9 cm.) was located on the lateral aspect of the thigh. The lower third of the femur had been shattered but the great vessel were intact. Present also was a perforating wound of the right buttock.

CASE 91

[redacted] 132nd Inf., while on patrol lying in an open foxhole was wounded by the direct burst of a Japanese mortar shell. His right foot was blown away. He was taken to the command post and remained there over night. On the following day he bled to death, while being carried to the rear on a litter. This was a preventable death. The aid man, when questioned, stated that he did not apply a tourniquet before beginning the litter carry because the stump was not bleeding at that time. He was wounded at 1800 hours, 4 April 1944, and died at 1300 hours on 5 April.

The photograph reveals the traumatic amputation stump.

CONFIDENTIAL



CASE 91



CASE 92



CASE 92

CASE 92

[redacted] 182nd Inf., while on guard beyond the perimeter tripped the wire to a U.S. Booby Trap (Grenade). He heard a noise and hit the dirt, but was struck in the left buttock by a fragment from a distance of 3 yards. He was wounded in the morning 29 March 1944. At the clearing station the wound was debrided and another incision made to remove the fragment. This incision was sutured. Sulfanilamide powder was insufflated into the entrance wound and it was left open. The patient died at 1100 hours 4 April 1944, of the gas gangrene which was diagnosed on the same day.

Postmortem examination revealed necrosis and infection of the wound and blood stream infection due to B.Welchii.

Photographs show both wounds with forcep grasping one of the sutures which were still in place.

CASE 93

[redacted], 129th Inf., while lying prone in the open firing at the enemy was struck by fragments from a Japanese mortar shell which burst on the ground nearby. He was wounded on 15 March 1944. On the following day a guillotine amputation was performed through the lower third of the right thigh because of impairment of blood supply. A shattered 4th left toe was removed and small wounds of the right buttock, lumbar region, right shoulder, and arm were debrided. [redacted] was evacuated on 19 March to a Station Hospital. He developed anuria 23 March and died at 0845, 25 March 1944. Death was attributed to uremia and cardio-respiratory failure. The uremia was thought to have been associated with "crush syndrome nephrosis".

At postmortem examination the various wounds were healing and uninfected.



CASE 94

CASE 94

[redacted], 148th Inf., while running along a jungle trail, was struck by fragments of a "short" U.S. 81 mm mortar shell which exploded between his legs. He was wounded at 0945, 1 April 1944. At a portable hospital surgical disarticulation of the left hip was done for an incomplete high traumatic amputation of the left thigh. Whole blood (2000 cc.) was administered before and during the operation. He died of shock 6 hours later.

Examination revealed traumatic amputation of the right leg in the upper one third, surgical disarticulation of the left hip, and mutilation of the right hand with multiple fractures.

The photograph shows the extent of the wounds.

CASE 95

[redacted] (JAPANESE), was wounded in action on an unknown date. He sustained multiple penetrating wounds of the right lower extremity and a superficial wound of the scalp from fragments of a U.S. land mine. He was treated at the Evacuation Hospital developed gas gangrene of the right leg and died at 1530 hours, 12 March 1944.

Examination revealed the characteristic odor and edmatous discoloration of gas infection. The right tibia and fibula were fractured in the middle third. The largest of the penetrating wounds measured 2.5 cm.

Photograph shows the metal fragments recovered from the gastrocnemius muscle.



CASE 96

CASE 96

[redacted] (32/1/1944), was wounded in action on 28 March 1944 and died at 2000 hours, 28 March 1944. Death was caused by gas gangrene of the left thigh.

Examination revealed a large wound (17 x 16.2 cm.) involving the medial surface of the thigh. The wound apparently had been caused by a high explosive shell fragment. The femoral vessels were intact but thrombosed. The femur was intact. The wound exhibited characteristic features of gas bacillus infection.

CASE 97

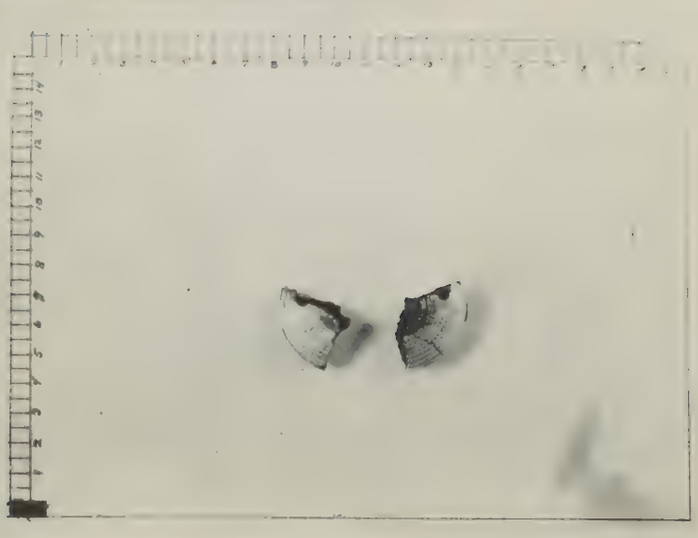
[redacted] 129th Inf., while walking beyond the perimeter hunting souvenirs, stepped on a T.S. type mine and was killed instantly on 30 March 1944.

Examination revealed multiple wounds of the head, chest and abdomen. One missile destroyed the antral, orbital and frontal areas of the skull. Only remnants of brain tissue remained. Another fragment entering the right thorax had resulted in perforation of the right ventricle and almost total destruction of the right lung. Two fragments were recovered, one from the pericardial sac, the other from the pleural cavity. A fragment penetrating the abdominal cavity had completely severed the right lobe of the liver.

Photographs show the extensive wounds of the head and thorax and the recovered metal fragments.



CASE 97



CASE 97

CASE 96

[redacted] was one of 4 soldiers assigned to a pillbox. They became alarmed thinking they were being surrounded by Japanese and left the box and separated to seek other cover. 3 of the men took cover in another foxhole. After a time [redacted] came to join them. He was met with rifle fire and hand grenades from his apprehensive companions as he walked down the trench to enter the hole. He was killed instantly at 2130 hours, 20 April 1944.

Examination revealed 7 wounds of the chest, scalp, back and lower extremities. These wounds were all produced by grenade fragments, no bullet wounds were found. Instantaneous death resulted from the thoracic injury: One fragment traversed the left supraclavicular fossa and the posterior first right intercostal space. The entrance wound was 2.5 cm. in diameter. This missile fractured the first rib, lacerated the left upper lobe and in crossing the mid line, fractured the bodies of the 4th, 5th, 6th and 7th dorsal vertebrae. Massive hemothorax was found. Bilateral fractures of the tibia and fibula and fracture of the left femur were present.



CASE 97

CASE 97

[redacted] 19th Engrs., left his foxhole to rescue a friend who had been wounded. While running he was struck by fragments of a Japanese 90 mm. mortar shell which burst on the ground 2 yards away. He died in the hospital several hours later at 0830 hours, 24 March 1944.

Examination revealed penetrating wounds of the left parietal and right kidney regions. The wound of entrance (1.5 cm. in diameter) in the left parietal region was filled with brain tissue. Stellate fracture lines coursed the cranial vault. The parietal lobe was lacerated and intracranial hemorrhage was marked. A small fragment of metal was removed from the brain tissue. Another fragment pierced the 12th rib right to enter the abdominal cavity, fragmented the right kidney and lacerated the right lobe of the liver. Massive hemoperitoneum was present.

Photograph shows the small fragment recovered from the brain.



CASE 100

CASE 100

[redacted] 1st Fiji Commando, while on patrol slipped on a U.S. land mine. He was killed instantly 1300 hours, 26 March 1944.

Examination revealed 7 wounds. A fragment entering the head produced an entrance wound (1.2 cm. in diameter) through the right, fronto-temporal region. In its course this fragment fractured the maxilla, zygoma, frontal and temporal bones and destroyed the right frontal lobe of the brain. A penetrating wound (2 cm. in diameter) of the abdomen was located 6 cm. above the umbilicus. The fragment producing this wound severed or perforated the pylorus, duodenum, jejunum and mesentery of the small bowel and was found lodged

SECRET UNCLASSIFIED



CASE 100

in the soft tissue at the aortic bifurcation. The peritoneal cavity was filled with blood. Another missile which produced a penetrating wound (2.2 cm. in diameter) in the left pectoral region severed the brachial plexus. This fragment was found in the subcutaneous tissue over the 6th rib in the posterior axillary line. In addition 2 penetrating wounds of the chest wall, 1 of the abdominal wall and 1 of the left thigh were discovered.

Photographs show wounds of the head and chest and metal fragments recovered from the chest wall and peritoneal cavity.

CASE 101

[redacted] 164th Inf., while crouching and advancing on patrol was struck by several .25 caliber Japanese bullets fired by a sniper from a distance of 50 to 75 yards. He was killed instantly at 1620 hours, 29 March 1944.

Examination revealed 6 perforating wounds. The thorax was perforated by a bullet entering posteriorally. The entrance wound (1.5 cm. in diameter) was found in the left 3rd intercostal space at the costovertebral junction and the exit wound (6.2 cm.) over the right deltoid prominence. In its course this missile fractured the 3rd rib, perforated the left and right upper pulmonary lobes and fractured the right clavicle and scapula. Massive bilateral hemothorax resulted.

SECRET UNCLASSIFIED



CASE 101



CASE 101

DESTROYED

The entrance wound (2.5 cm. in diameter) in the abdominal wall was situated in the left lower quadrant and the exit wound (5 cm. in diameter) on the right side of the scrotum. The missile producing these wounds lacerated the sigmoid colon, fractured the symphysis pubis, and avulsed the right testicle. The left femur was fractured in its lower third by a bullet which produced an oblique perforating wound. This bullet traversed the thigh from the lateral aspect of the upper third to the medial aspect of the lower third. In addition perforating wounds of the left buttock, left shoulder and left ear were present.

The wound tract traversing the abdomen and scrotum is demonstrated in one photograph by the inserted catheter. A bullet found in the clothing is shown in the other photograph.

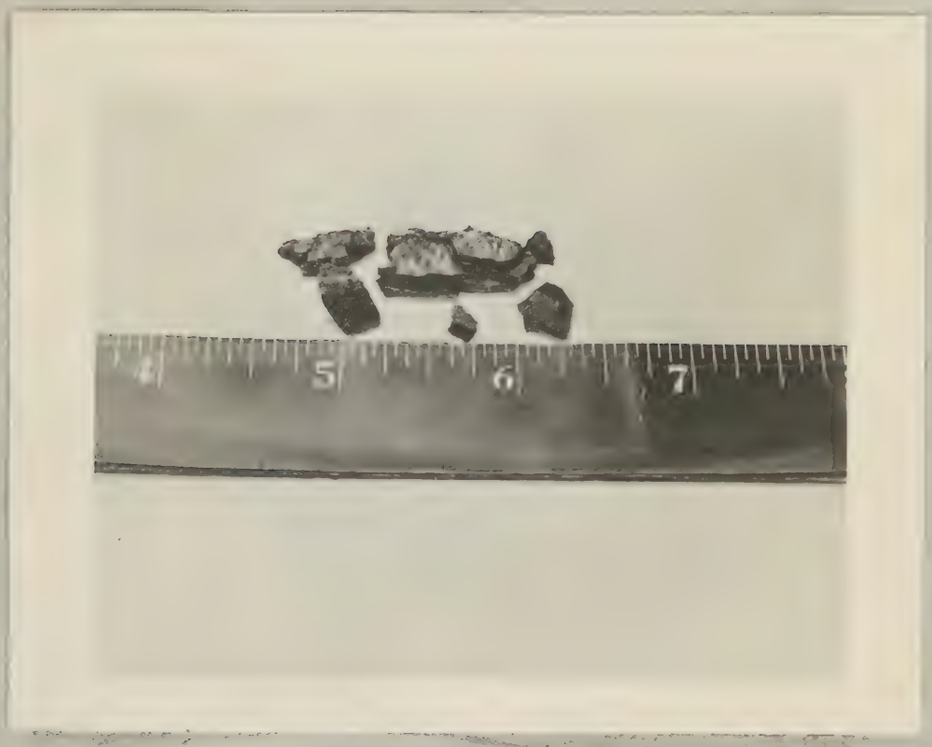


CASE 102

CASE 102

[redacted] while in front of the perimeter cutting down trees to improve line of fire stepped on a U.S. land mine and was killed instantly at

DECLASSIFIED



CASE 102

1015 hours, 1 April 1944.

Examination revealed 18 widely distributed wounds. The head wound was obviously responsible for immediate death. The fragment which produced the extensive head wound (10 x 6 cm.) destroyed the right orbit, right frontal bone and avulsed both frontal lobes and part of the right parietal lobe of the brain. In addition there were numerous penetrating and perforating wounds of the upper and lower extremities and abdominal and chest walls. The following compound fractures were found: right tibia, left tibia and fibula, right femur, right ulna and mandible.

Photographs show the wound of the head and some of the recovered metal fragments.

CASE 103

[redacted] 140th F.A., while walking through thick jungle on patrol was shot by .25 caliber Japanese bullets fired from a distance of 10 yards. He was wounded at 1600 hours, 14 March 1944 and reached the hospital 1 hour later. The wounds sustained necessitated multiple operations. The severed left axillary vein was ligated and the wound left open. Exploratory cystotomy revealed no perforation of the urinary bladder making suprapubic drainage unnecessary. Compound comminuted fractures of the right femur and ilium were accompanied by extensive

wounds of soft tissue about the right hip joint and buttocks. These wounds were debrided. The patient died at 1450 hours, 16 March 1944. His death was attributed to gas gangrene and peritonitis.

Examination revealed a foul, edematous, discolored crepitant wound of the right hip. A sinus tract containing a serosanginous exudate led to the fractured head and neck of the femur. The edema and discoloration extended above to the wound into the right buttock. An operative incision was present in the low mid line. The terminal ilium was gangrenous as a result of an unexplained thrombosis of the mesenteric vessels. Gangrene of the ilium accounted for the presence of a diffuse sero-purulent peritonitis.

CASE 104

[redacted] 132nd Inf., stepped on a mine while on an authorized mission in front of the perimeter arming U.S. land mines at 0830 hours, 27 March 1944. He was taken immediately to the Clearing Station. There his numerous wounds, including the wound of a traumatic amputation of the left foot, were debrided. He died of shock at 1445 hours, 27 March 1944.

Examination revealed 13 wounds. The 4 wounds of the left lower extremity were: the wound of an amputation stump in the lower third of the leg, a linear wound 12.5 x 6.2 cm. over the knee accompanying a compound comminuted fracture of the patella, an irregular wound 10 cm. in length on the medial aspect of the knee and a superficial wound on the medial surface of the thigh. 3 wounds of the right leg were seen, a gutter wound 7.5 cm. long on the dorsum of the foot, a small penetrating wound of the ankle accompanying a fracture of the internal malleolus, and a superficial wound of the calf. A large wound (12.5 x 7.5 cm.) of the right buttock was associated with a compound fracture of the sacrum. Present also was a compound comminuted fracture of the right ulna. In addition wounds of the back (2), right forearm (2), and left buttock (1), were found.

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8. CIRCUMSTANCES AND PROTECTIVE MEASURES

A study of the circumstances under which wounds occur may yield information regarding the effectiveness of weapons under battle conditions, the results of training and the need for protective measures. Wounds occur under a variety of conditions which make classification difficult. However, an attempt was made to determine the position and occupation of the soldier when wounded, the type of cover and the distance from the shell burst or weapon. This information was obtained from the wounded man or from his comrades or from both. The circumstances under which the soldier was wounded usually could be obtained in considerable detail. However, the caliber and exact type of weapon frequently could not be identified other than as belonging to the general classification used in these tables.



Fig.82: Photograph illustrates necessary exposure of head and upper extremities.

When the subject of "cover" is viewed broadly, casualties fall naturally into three general groups depending upon the relative degree of protection available at the time of wounding. In the first group are placed those who had the best protection, usually a well constructed pillbox covered by fairly heavy logs. In the second

group are those who had no overhead "cover", but were protected on all sides by well dug-in holes or trenches. The third group comprised those with the least protection, and is subdivided into those who had no protection whatsoever, and those who had partial protection. A soldier in a shallow foxhole or behind a tree or log would be considered one with "partial protection". Eighty one casualties produced by miscellaneous weapons whose position at the time of wounding was not considered significant are excluded, but will be discussed later in this section. In 150 instances the "position" was not stated. Data regarding "protection and position" was available therefore in 1,557 cases, and is summarized in Table 1. Those who were erect, standing, walking or running were included under the classification "standing".



Fig.83: Showing "necessary" and "unnecessary" exposure in a position on Hill 700.

Those who had considerably less body area exposed, whether they were sitting, crouching or kneeling, are placed in the group designated "sitting". The term "prone" does not require explanation. By weapon these casualties were distributed as follows: mortar 39.6 per cent, rifle 26.8 per cent, grenade 13.5 per cent, artillery 11.4 per cent and machine gun 8.7 per cent.

TABLE I

		Rifle	Mach.Gun	Grenade	Mortar	Arty.	Totals No.	%
Standing	open	184	57	49	189	88	567	36.5
	cover	4	1	1	5	2	13	0.8
Sitting	open	92	25	39	114	15	285	18.4
	cover	10	0	1	15	2	28	1.8
Prone	open	72	30	62	122	26	312	20.1
	cover	13	3	5	12	2	35	2.3
Pillbox		11	6	33	64	26	140	9.1
Trench-hole		29	12	19	91	26	177	11.0
Totals		415	134	209	612	187	1557	100.0

a. Influence of position on number of casualties.

It is obvious that the body surface exposed depends upon the "position" of the soldier when wounded and should bear some correlation with the number of hits. It is important to know whether the number of hits depends solely upon the body surface exposed, or whether it is greater for aimed weapons. Data relating to this problem was obtained by examining the least protected group (standing, sitting and prone) which constitutes 79.9 per cent of the total (1,557).



Fig.84: Little protection is afforded by this type of machine gun emplacement.



Fig.85: A shallow 81 mm. mortar emplacement which affords moderate protection.

TABLE II
("covered and uncovered")

	Aimed Weapons		Unaimed Weapons		Totals	
Position	No.	%	No.	%	No.	%
Standing	246	50.2	334	44.6	580	46.8
Sitting	127	25.8	186	24.9	313	25.2
Prone	118	24.0	229	30.5	347	28.0
Totals	491	100.0	749	100.0	1240	100.0

By reference to Table II it is apparent that there are twice as many casualties among the "standing" as there are among either the "sitting" or the "prone". Furthermore, the number of casualties is approximately equally divided between the two latter groups. When the factor of "cover" is exeluded by omitting the small number who had slight protection, the relative proportion of casualties in the three subdivisions remains unchanged. This is what might be expected were all missiles unaimed and travelling at random.



Fig.66: A cleared field of fire in front of ~~the on~~ the 129th sector, where the terrain was also favorable for the use of tanks.

TABLE III
("covered" omitted)

	Aimed Weapons		Unaimed Weapons		Totals	
Position	No.	%	No.	%	No.	%
Standing	241	52.4	326	46.2	567	48.7
Sitting	117	25.4	168	23.9	285	24.5
Prone	102	22.2	210	29.9	312	26.7
Totals	460	100.0	704	100.0	1164	99.9

In this event the number of wounds received would be in approximate proportion to the projected body area exposed. On the basis of the foregoing finding it appears that in this particular jungle campaign, the number of casualties depended upon random unaimed hits which were roughly in proportion to the body area exposed.

b. The Relatively Well Protected

In the total group (1,557), 317 or 20.1 per cent were wounded in well covered pillboxes or well dug in, but uncovered holes or trenches. These casualties were nearly equally divided between the pillbox (44.4 per cent) and the open trench (55.2 per cent). Many more of this group were wounded by aimed weapons (81.9 per cent) than by unaimed weapons (18.1 per cent). However, the aimed weapons produced 70.7 per cent of the casualties in the open trench, but only 29.3 per cent in the pillbox. Casualties from unaimed weapons were approximately equally distributed between the pillbox (48.1 per cent) and the open trench (51.9 per cent). One may, therefore, conclude that the covered pillbox offers relatively greater protection against aimed weapons.



Fig.67: Showing typical jungle terrain. Members of a patrol crossing the Piva River on way back to front lines.

c. Type of Action

The number wounded on patrol, or defensive and offensive action is shown in Table IV.

TABLE IV

	Rifle	Mach.Gun	Grenade	Mortar	Artillery	Totals
Patrol	105	34	25	35	29	228
Defensive	253	78	152	588	136	1207
Offensive	58	36	38	50	3	185
Total	416	148	215	673	168	1620

Table V shows the relative percentage distribution of these casualties according to the aimed (34.8 per cent) and unaimed weapons (65.2 per cent). A much higher percentage, however, were wounded on both patrol and offensive action by the aimed weapons. On defensive action the reverse obtains.

TABLE V

Type of Action	Aimed Weapons	Unaimed Weapons	Total
Patrol	24.6%	8.4%	14.1%
Defensive	58.8	83.0	74.5
Offensive	16.6	8.6	11.4
Totals	100.0	100.0	100.0



Fig.88: View of Numa Numa trail beyond perimeter used for evacuation of casualties from outposts and patrols.

d. Range and Distance from Burst

The approximate range was known in 339 casualties produced by the rifle and in 121 casualties resulting from machine gun fire. In Table VI this group is tabulated in percentages according to range and disposition. The higher lethal effect of bullets at close range should be noted. At longer range it would appear that the casualties received either minor or vital wounds since none received wounds of sufficient severity to cause evacuation to the U.S. The distance from the shell burst or weapon was estimated in most instances and is, therefore, open to considerable error. It is likely that the actual distance from a shell burst was greater than the estimated distance. In future studies suitable samples might be used to check on this error. Furthermore, indoctrination of troops, before combat, regarding the importance of such data might lead to more accurate observation.

TABLE VI

	Dead		Duty		Evacuated to U.S.		Total Average	
Yards	Rifle	Mach.Gun	Rifle	Mach.Gun	Rifle	Mach.Gun	Rifle	Mach.Gun
0-25	54.7%	40.3%	17.9%	3.2%	37.7%	28.6%	33.9%	28.1%
25-50	27.3	45.1	8.3	6.4	19.3	35.7	16.8	33.1
50-75	8.5	6.4	37.2	51.6	42.9	35.7	29.5	24.8
75+	9.4	8.1	36.5	38.7	0.0	0.0	19.8	14.0
Totals	99.9	99.9	99.9	99.9	99.9	100.0	100.0	100.0

Approximate distances from shell bursts (including "knee" mortars) were known in 623 casualties produced by the mortar and in 176 caused by artillery. The percentage distribution of these casualties according to the disposition of the patient is shown in Table VII. In the jungle the effect of a shell burst should be more limited than in open terrain. Approximately 60 per cent of the casualties were under ten yards from the burst.

TABLE VII

Ranges	Dead		Duty		Evacuated to U.S.		Total Average	
Yards	Mortar	Art.	Mortar	Art.	Mortar	Art.	Mortar	Art.
0-10	79.4%	86.0%	64.5%	50.5%	66.6%	53.8%	66.7%	59.6%
10-20	8.2	9.3	19.1	21.5	22.0	19.2	18.3	18.2
20-50	11.0	4.7	12.1	15.9	7.6	11.5	11.2	12.5
50+	1.4	0.0	4.3	12.1	3.8	15.4	3.8	9.7
Totals	100.0	100.0	100.0	100.0	100.0	99.9	100.0	100.0

Similar results are tabulated for the grenade in Table VIII. It is rather surprising to find that the effectiveness of the Japanese hand grenade extends beyond five yards, as evidenced by the fact that 25.1 per cent were wounded at this distance. However, it is possible that some of these casualties were produced by U.S. grenades.

TABLE VIII

Range Yards	Dead	Duty	Evacuated to U.S.	Total
0-3	100.0%	67.3%	56.7%	67.6%
3-5	0.0	6.4	13.5	7.2
5+	0.0	26.3	29.7	25.1
Totals	100.0	100.0	99.9	99.9

e. Time Phase

In Table IX casualties are separated according to the period of time in which they occurred. The first phase extends to the beginning of the battle of the perimeter (15 February to 7 March), the second phase covers the intensive period of activity of (8 March to 28 March) and the last phase, the subsequent relatively inactive period (29 March to 21 April 1944). Eighty per cent of the casualties occurred during the battle of the perimeter.

TABLE IX

	Rifle No.	Mach Gun No.	Grenade No.	Mortar No.	Art. No.	Totals No.
First Phase	35	7	11	39	35	127
Second Phase	308	111	184	622	140	1365
Third Phase	102	34	29	32	18	215
Totals	445	152	224	693	193	1707

Table X summarizes the distribution of casualties in percentages according to their mode of production. Sixty five per cent were wounded by unaimed and the remainder by aimed weapons.

TABLE X

	Aimed Weapons	Unaimed Weapons	Totals
First Phase	7.1%	7.7%	12.6%
Second Phase	70.1	85.2	80.0
Third Phase	22.8	7.1	7.4
Totals	100.0	100.0	100.0

f. Miscellaneous Weapons and Circumstances

Eighty one casualties (4.5 per cent of 1,788) resulted from the following miscellaneous weapons, land mine (excluding grenade booby traps) 34, aerial bomb 14, .45 caliber pistol 14, powder explosions and flares 6, bangalore torpedoes 9, bazooka 2 and bayonet one. Enumeration of the very varied circumstances surrounding the wounding of these patients serves no purpose since no general conclusion can be derived.

When all casualties are considered, however, (including those produced by miscellaneous weapons) several circumstances deserve mention and are quoted from the section on U.S.weapons. "Nineteen were wounded by the accidental discharge of a rifle by a fellow soldier. Mistaken identity resulted in thirteen deaths and the wounding of six others. Eight of these deaths were occasioned by the soldier seeking to relieve himself at the toilet during the night. Self-inflicted wounds, accidental or intentional were responsible for ten casualties, three of whom died. The accidental tripping of land mines and booby traps produced fourteen deaths in a total of forty wounded. Four soldiers were killed while souvenir hunting, two by the rifle and two by land mines."

In jungle warfare a fair number of casualties result from the overhead explosion of mortar or artillery shells, or aerial bombs overhead, as a result of detonation on impact with a tree or its branches. Such explosions are designated "tree bursts" as distinguished from "ground bursts". In 900 instances there were 93 (11.5 per cent) "tree bursts". Mortar shells constituted 58.1 per cent of all "tree bursts", artillery shells 34.4 per cent and aerial bombs 7.5 per cent. Ground bursts were divided as follows: mortar shells 79.1 per cent, artillery shells 20.0 per cent and aerial bombs 0.9 per cent.



[Japanese]

Fig.89: A mortar shell bursts in front of two men on a patrol. Many casualties were caused by our own mortar and artillery"shorts".

g. Protective Measures and Recommendations

(1) Pillboxes. Opinion has been expressed that the large size of the firing slit resulted in casualties which might have been avoided by a smaller opening. In some instances, nearby tree snipers were able to direct fire through the firing slit. Because of this fact it has been suggested that an eave overhanging the firing slit might be a useful additional means of protection. Our findings indicate that gun fire directed through the slit is of little importance. Wounding through the firing slit did occur in 10% (8.7 per cent) instances in 1,557 casualties. However, in this group the aimed weapons (rifle and machine gun) were responsible for only 9 (8.6 per cent) of those so wounded. In view of this small number the advisability of the overhanging eave is doubtful. However, a considerable number of casualties (95) are caused by shell fragments passing through the firing slit. This would indicate the need for keeping the size of the firing slit as small as is consistent with observation and maneuverability of weapons within the pillbox.

Protection against the hand grenade was afforded by the use of wire ("chicken") net at night to cover peep slit openings, and was favorably recommended. Some type of rubber net might serve to "bounce off" the unexpected grenade even better than the wire net. The earth should be sloped from the slit opening so that grenades will roll away.



Fig.90: View of entering a well constructed pillbox showing size of firing slit.



Fig.91: Fire netting [illegible] firing slits was used successfully to "bounce off" enemy grenades.

The construction of pillboxes might be improved by the use of heavier (12 inch) logs. Hard wood is recommended if obtainable as termites destroy soft timber quickly. Some concrete could be used to advantage. Since the location of the pillbox is usually known to the enemy, camouflage should be sacrificed for sturdy construction. The earth floor in a square log pillbox should not be excavated out to the edges of the logs. On the contrary a stronger pillbox results if the central excavation is made circular in shape, thus leaving more earth in the corners.



Fig.92: Photograph reveals unnecessary exposure and concentration of men.

(2) Combat Training. The majority opinion held that the Japanese soldier made better use of cover than did our troops, and were better trained at "digging in" quickly. They utilized all natural cover. They crawled close to the ground and their foxholes were small, efficient and well suited to the purpose intended. On the contrary our troops were frequently careless in exposing themselves unnecessarily and oftimes were content with foxholes which were entirely too shallow. Many wounds were received because soldiers crawled with buttocks elevated, making a large silhouette. In training and staging areas more time devoted to "digging in" would serve not only to stress the importance of adequate cover, but would also develop the necessary muscle.



Fig.93: Infantry advancing behind tanks. Many casualties occurred when the Japanese withheld fire until the tanks had passed.

When under fire the importance of dispersion should be repeatedly emphasized. For example in one instance thirteen men preparing to enter a truck were killed or wounded by a single shell. Neglect of this principle resulted in 600 enemy killed by our artillery fire in one area.

(3) Medical Suggestions. Aid men should receive more preliminary training in vena puncture. Lack of familiarity and practice in this technique frequently delayed the administration of plasma. Since patients cannot be evacuated at night from front line positions, every soldier should know the principles of first aid. Under combat conditions similar to these at Bougainville, it is felt that the oral administration of sulfanilamide medication should be discontinued in the field unless on patrol far from medical installations. It was often difficult to know later in the hospital whether a man had received this medication and, if so, in what amounts. It was estimated that less than 10 per cent took the drug by mouth after being wounded. This uncertainty as to dose frequently delayed adequate sulfonamide therapy. Finally the practice of sending aid men forward to remove the dead under fire is very demoralizing and should be condemned.

(4) Body Armor. The subject of protection would not be complete without some expression of opinion regarding



Fig.34: Natural jungle growth provided excellent camouflage. The soldier is examining an abandoned Japanese gun position.

the advisability of body armor. Many line officers believed that under certain tactical situations the judicious employment of some type of body armor would be definitely advantageous. Its routine use is not recommended. The objections most frequently raised are, that the infantry foot soldier is already burdened with a maximum amount of weight, that any further equipment would be cumbersome and would interfere with fighting efficiency and finally that too much protection induces an "armor complex". These objections could be overcome if the use of armor were restricted to a special circumstance. When the tactical situation demanded body armor, it could be transported to that point, issued and later collected when the objective had been attained. In the type of combat at Bougainville the soldier did not carry a "full pack", obviously for brief intervals all unessential equipment could be discarded in favor of armor.

9. SUMMARY

The primary purpose of this report is to evaluate the relative effectiveness of the different weapons as casualty producing agents. In order to achieve this aim it was necessary to determine and to correlate the varied circumstances surrounding wound production in each individual case. It was essential to know what weapon caused the wound, the anatomical region wounded, the range and distance from the burst, the available protection, the degree of disability, the treatment and disposition of the patient and all details relating to death. This report comprises a study of all battle casualties (living and dead) occurring in the Army Ground Forces on Bougainville Island from 15 February to 21 April 1944.

a. History

The Bougainville campaign possesses certain features which are not ordinarily found in jungle warfare. A beachhead was made in virgin jungle for the purpose of establishing airfields. Not until four months later did the enemy engage in the major large scale attack referred to as the "Battle of the Perimeter". In this interval the perimeter was extended and strongly fortified and an excellent system of roads was constructed within the defended area. When attack came, we possessed superior force both in numbers and equipment. We had gained control of the air and in addition had the advantage of overwhelming artillery superiority. Ample vehicular transportation and smooth all weather roads facilitated supply and evacuation. Medical installations had been completed which were easily accessable and adequate to meet all exigencies. Consequently a high standard of medical care was maintained. The Japanese on the contrary were handicapped by the necessity of taking offensive action against a well established perimeter defended by a greater number of better equipped troops. Furthermore, their supply problem was very difficult. They were compelled to transport supplies chiefly by pack through dense jungle and over narrow rugged mountain trails. However, with the exception of artillery weapons and shells, the enemy, by dogged effort were able to keep adequate supply of arms and ammunition.

b. Casualties

The United States forces at Bougainville sustained 2,335 casualties from 15 February to 21 April 1944, of these 16.9 per cent died, 69.5 per cent were returned to duty and 13.6 per cent were evacuated to the United States. In the total group there were 547 who were so lightly wounded that they were returned directly to duty from the battalion aid posts or collecting stations. Since the effect of weapons on this group was minimal and since these soldiers were not actually "lost to combat", they were excluded from the remainder of the study. Therefore, all subsequent percentage figures are based on 1,788 battle casualties who were admitted

to hospitals, or were killed in action. Using the 1,788 casualties as a basis we find that one of four men wounded died, making a mortality of 22.1 per cent. The living wounded numbered 1,393, of these 77.2 per cent were returned to duty and the remainder evacuated to the United States.

The majority of casualties (78.8 per cent) occurred during the "Battle of the Perimeter", a period arbitrarily defined as extending from 6 March to 28 April 1944. Most of these casualties occurred within our lines. Because of the fortuitous circumstance of hospital accessability, these wounded obtained adequate medical care, usually within one hour, but in most instances in much less time. Patrol activity was chiefly responsible for the small number of casualties which occurred before and after this battle. These casualties constituted the major problem in the evacuation of the wounded. During the "Battle of the Perimeter" the American loss was 310 killed in action as contrasted to 8,527 Japanese dead, a ratio of 1 to 24.6.

c. Anatomical Distribution of Wounds

A striking contrast is observed in the percentage distribution of wounds in the dead, in the living and in both groups combined, when classified according to the anatomical region involved. (See Table I).

TABLE I

Relative Order	1	2	3	4	5	6
Total Casualties	Lower Ext. 22.7%	Head 21.4%	Multiple 18.6%	Upper Ext. 17.9%	Thorax 12.9%	Abdomen 6.6%
Dead Only	Head 36.4%	Multiple 25.6%	Thorax 22.0%	Abdomen 12.2%	Lower Ext. 3.5%	Upper Ext. 0.3%
Living Only	Lower Ext. 28.2%	Upper Ext. 22.7%	Head 17.3%	Multiple 16.7%	Thorax 10.4%	Abdomen 4.7%

d. Wound Distribution

It was found that the distribution of wounds is dependent largely upon exposure to the random missile and not upon directed fire. This is demonstrated clearly by comparing the actual with the expected number of hits in each anatomical region. This was done by superimposing the percentage of hits over the percentage mean of the projected body area. In this way the directed fire (rifle) was compared to the undirected fire (mortar) and to the total hits by all weapons. A close correlation exists between the expected number of hits and the mean projected body area except in the case of a single region, the head. In the head the number of hits exceeded the expectancy by more than 100 per cent. This would indicate that in combat exposure of the head exceeds that of any other anatomical region. However, the fact that percentage of rifle hits exceeded the percentage of unaimed mortar hits by a perceptible margin would tend to indicate that the factor of marksmanship does account for a moderate number of head wounds.

e. Effectiveness of Weapons

In Table II the number of battle casualties produced by the different weapons is shown in relation to the "relative lethal effect" of each weapon. A clear distinction exists. The total number of casualties produced by a given weapon reflects not only the extent of its use by the enemy, but also the effectiveness of that weapon when employed under the particular circumstances of that battle. On the other hand the "relative lethal effect" of a weapon is defined as the percentage killed by all hits and is a measure of the effectiveness of that weapon under all conditions (providing facilities for medical care are comparable and constant). For example, while the mortar produced more casualties in this campaign, the machine gun had the highest lethal effect.

TABLE II

Relative Order	1	2	3	4	5
Number of Casualties	Mortar 38.7%	Rifle 24.8%	Grenade 12.5%	Artillery 10.8%	Mach. Gun 8.5%
Relative lethal Effect	Mach Gun 58.0%	Rifle 32.2%	Artillery 22.3%	Mortar 11.8%	Grenade 6.3%
Total Dead	Rifle 36.7%	Mach. Gun 22.2%	Mortar 20.7%	Artillery 10.9%	Grenade 3.5%

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A true measure of the effectiveness of a weapon cannot be obtained by a consideration of the total number of casualties and the relative lethal effect alone. A third factor must be considered, namely, the severity of the wound in the living. An estimate of the severity of the wound may be obtained by classifying the living casualties according to the ultimate disposition of the patient, whether he was returned to duty from the first or second echelon, or evacuated to the United States. A still more important criterion of the effectiveness of a weapon from the standpoint of winning a battle is the ability of the wounded soldier to continue combat. This was determined by classifying the wounded according to arbitrary criteria based on whether the soldier could have continued combat for a few hours if his life were at stake. When measured by both of these standards the relative effectiveness of the different weapons was found to be of the same order as follows: (1) machine gun, (2) rifle, (3) artillery, (4) mortar, (5) grenade.

Sufficient ballistics data is not available in this theatre to determine the average velocity of shell fragments producing casualties. The exact size of the shell causing these casualties is also unknown. Furthermore, there is insufficient clinical data to determine the size and mass of the fragments causing casualties. However, if one assumes the average velocity of bullets is greater than that of shell fragments at the point of impact, these findings suggest that the effectiveness of a weapon is a function of the velocity of the missile.

TABLE III

Relative Order		1	2	3	4	5
Lost to Battle	(a) Distribution by Weapon	Mortar	Rifle	Mach Gun	Arty.	Grenade
		35.6%	32.3%	12.6%	10.5%	8.8%
	(b) Effectiveness of Weapon	Mach Gun	Rifle	Arty.	Mortar	Grenade
		85.5%	74.8%	56.5%	53.1%	40.6%
Lost to Combat	Distribution by Weapon	Rifle	Mortar	Mach Gun	Arty.	Grenade
		37.7%	27.6%	18.0%	9.5%	6.5%
	Effectiveness of Weapon	Mach Gun	Rifle	Arty.	Mortar	Grenade
		75.0%	52.3%	30.6%	24.5%	18.8%

"Lost to Battle"-Casualties dead evacuated to the rear echelon and to the United States.

"Lost to Combat"-Casualties dead or unable to continue to fight "if life were at stake".

(a) Percentage of casualties wounded by each weapon.
(b) Percentage effect of the weapon per se.

f. Comparison of Japanese and U.S. Weapons

A comparison of the effects of Japanese and U.S. weapons shows a lower lethal effect for both the enemy artillery and the grenade. The fact that our artillery was predominately heavier than that of the Japanese may explain its greater relative effectiveness. The low lethal effect of the enemy grenade appears to be characteristic of that weapon. (A comparison of weapons was possible in only a relatively small number of instances, since records were available for only 219 casualties produced by U.S. weapons.)

g. Circumstances

On the basis of the study of a large group (79.9 per cent) who had relatively little or no protection when wounded, it was found that the number of casualties depended upon random unaimed hits which were distributed roughly in proportion to the body area exposed. The remaining casualties which occurred under the circumstance of relatively good protection were equally distributed between the pillbox and the uncovered foxhole or trench. Aimed weapons were responsible for 81.9 per cent of the casualties in the uncovered trench or foxhole and for only 29.3 per cent in the pillbox. On patrol and offensive action the majority were wounded by the aimed weapons, whereas, on defensive action, the reverse obtained. Eighty per cent of the casualties in this study occurred during the "Battle of the Perimeter".

A number of casualties resulted from careless exposure, failure to dig-in and failure to take advantage of natural cover. A large number of casualties (219) resulted from our own weapons. These findings indicate the need for even greater emphasis on the importance of "cover". The training program should also stress the avoidable circumstances under which troops are killed or wounded by careless behavior.

h. Medical Treatment

Exceedingly advantageous circumstances surrounded the treatment of the wounded at Bougainville. In the treatment of 2,015 casualties the low mortality of 3.7 per cent was obtained. Experience in this campaign indicates a need for portable blood banks. Shock and hemorrhage were well treated by the liberal use of plasma. Whole blood transfusions were used more extensively than in any previous campaign in the South Pacific. Nevertheless, a wider utilization of blood transfusions would have been beneficial, because of large blood volume replacement needed. Fractures were well treated by plaster immobilization. There were no deaths due to compound fractures of the extremities. First aid treatment was excellent, and in only two instances did a death occur which might have been attributed to an aid mans error of judgment. Inadvisable evacuation of patients before recovering from shock possibly contributed to a fatal outcome in a few instances.

i. Postmortem Examinations

Hemorrhage was the most common cause of death in 104 autopsies. Frequently four or more liters of blood were found in the pleural or peritoneal cavities. Extensive brain damage ranked second in producing death. Accurate determination of the causative missile by the appearance of the wound was not possible in either the dead or the living. There was no constant relationship between the size of the wound of entrance and exit and the underlying structural damage. "Blast Effect" of high velocity missiles was frequently noted in the more solid organs as well as in the lung and brain.

NOTE: This report has been written without the benefit of adequate ballistics data. Hence some of the assumptions regarding the velocity of missiles may be erroneous.

10. CONCLUSIONS

a. The Objective

The ultimate aim in the study of wound ballistics is to provide data which will allow the machinery of war to produce more casualties among the enemy. These data may enable an army to devise more efficient weapons, develop better protective measures and will eventually reflect in improving the care of the wounded.

b. The Data Required

Field studies should yield information which permits the proper evaluation of weapons as casualty producing agents. The effectiveness of a weapon may be measured by the number of casualties it produces, and by the severity of the wound. Wound severity in turn must be gauged not by local appearance, but by the ultimate disposition or length of disability of the patient. The following factors, therefore, must be considered:

(1) Weapons. Type and proportion of weapons employed, the range or distance from the shell burst, and the mass or velocity of the missile should be determined.

(2) Local Circumstances. The number and character of casualties reflect battle condition; hence, local conditions must be ascertained. It is desirable to know the position and occupation of the soldier when wounded, the available cover, terrain and the tactical situation.

(3) Medical Care. A detailed study of the patients medical record is essential and should include a description of the wound, with the exact location of the point of entry, evaluation of the treatment and postmortem findings in case of death. The degree of disability measured in time lost from combat must be ascertained and evaluated, together with the mortality rates for each weapon.

c. The Methods and Results

Data in this report were obtained by personal interview and by questionnaire. Because the wounded man frequently knew less about the circumstances of wounding than his uninjured companion, witnesses were interviewed at the front as soon as possible after the action. Hospital staff officers were not trained in the study of wound ballistics and when casualties were heavy they were fully occupied with the care of the wounded. For this reason it was found desirable to have an officer of the ballistics team assemble clinical data at the various hospitals. Since the action was confined to a small geographical area and transportation facilities were excellent, the collection of essential information was relatively easy. Under these rather ideal circumstances the report falls short of attaining the full advantage of the opportunity presented for the study of wound ballistics. Its merit, if such there be, lies in the fact that it presents data on all who were killed and wounded in one battle.

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d. The Lessons Learned

(1) The personal interview is preferable to the questionnaire. The questionnaire may be utilized as an adjunct, if its use is supervised by a ballistics investigator and its accuracy repeatedly checked.

(2) There is need for the definition and standardization of terms used in the study of wound ballistics. To obtain comparable reports it is necessary to adhere to some uniform plan of collecting and recording data.

(3) The number of the wound ballistics team personnel was inadequate. For a comparable volume of work the number should be doubled.

(4) A wound ballistics team should be assigned to the combat unit one month prior to D-day. This will allow for indoctrination of medical officers, aid men and troops. In this interval experienced team members may furnish valuable instruction by outlining the avoidable circumstances under which troops are killed or wounded.

(5) Surgeons in hospitals along the line of evacuation should be instructed regarding the clinical data desired. They should understand the general objectives of the study in order to enable them subsequently to furnish the desired information.

(6) The study of wound ballistics in the field requires special training and aptitude. It necessitates an attention to detail which an overloaded hospital staff does not have the time to devote during battle. Information collected in the routine manner without the aid of trained investigators lacks uniformity and accuracy. In order to collect adequate and accurate data it is essential that a full time wound ballistics team be assigned for that purpose.

APPENDIX I

MEDICAL ACTIVITIES IN RECENT ENGAGEMENT

The following is an account of the activities of officers and enlisted men of the Medical Detachment, 129th Infantry, in an engagement with the enemy during the period 14 February, 1944, to 16 February, 1944, in a sector to the front of OP #7, 129th Infantry.

A reinforced platoon composed of personnel from the 1st Battalion, assigned the mission of organizing and manning a new outpost approximately 10,000 yards to the front of OP #7, left the bivouac area of the 1st Battalion at approximately 0700L, 14 February 1944, via vehicle to the CP of the 3rd Battalion, 145th Infantry, and thence proceeded by foot. The patrol was accompanied by one officer and four enlisted men of the 1st Battalion Medical Section, per instructions issued by Headquarters 129th Infantry.

The patrol proceeded without incident to OP #7, approximately 4,000 yards to the front of our lines. Thence it marched in route column up the Laruma River and, at a point approximately 5,200 yards forward, scouts of the patrol reported the discovery of enemy emplacements. A plan of action was mapped by the patrol leaders, but before the plan could be carried out the patrol was attacked from the front and flank by the enemy. Personnel of the patrol withdrew to covered positions and, during the process of the withdrawal, enemy mortar and rifle fire caused 10 casualties, four of which were fatal. One of the four dead was buried during the initial phase of the engagement. This casualty had been killed near the enemy position, and inasmuch as heavy fire prevented the evacuation of his body, he was buried there to prevent his capture by the enemy. Heavy enemy fire prevented the recovery of the three other bodies. Of the six wounded men, five were removed to covered positions during the withdrawal and three of the five were taken to OP #7. They were treated there by medical personnel attached to the OP. The other wounded were taken to the point where the patrol set up an overnight bivouac and were given all possible first aid and treatment.

Communication with the patrol had been severed and as a result no report of the engagement was received at the CP, 129th Infantry, until approximately 1800L. The Regimental Surgeon, upon being informed of the developments, immediately made arrangements to take care of the evacuation of the casualties. The Assistant Regimental Surgeon, Capt. Mark W.Dick, and the non-commissioned officer in charge of the Medical Detachment's transportation section, T/4 Vincent J. Walter, were ordered to proceed immediately by vehicle to OP #7 for this purpose. Within five minutes after receipt of the orders

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Capt. Dick and T/4 Walter were enroute. At the CP, 145th Infantry, they were joined by four armed guards from the 1st Battalion, 129th Infantry, who accompanied them to the OP. The trip, over a poor trail, was made more difficult by the torrential rain which had fallen continuously since early afternoon. They reached the OP at approximately 2000L. Three wounded men had already arrived by then at the OP and Capt. Dick administered blood plasma and morphine to the wounded. Thereupon, he instructed T/4 Walter to bring the three wounded men back to the Division Clearing Company. Driving at night through the jungle over the mud-ridden trail, T/4 Walter, accompanied by four armed guards, accomplished this mission by approximately 2400L. Because of the condition of the wounded, it was necessary to drive slowly and carefully during the trip.

Meanwhile, Capt. Dick, having been informed that there were additional casualties at the point of the engagement, transmitted a request to the Regimental Surgeon for four litter squads. The Regimental Surgeon contacted the Surgeon, 1st Battalion, Capt. Carl C. Ernst, and advised him of this request. Capt. Ernst ordered 18 enlisted men, under the leadership of S/Sgt Glenn J. Siewenie, to proceed immediately to OP #7. These men joined the forward elements of the reinforcements sent out from the 1st Battalion, 129th Infantry, and left their bivouac area at approximately 0245L.

The going over the muddy road and through the dense undergrowth was slow and difficult and after continuous marching the medical personnel reached the OP at approximately 0430L. Upon arrival there, it was possible for the aid men to obtain some rest before accompanying the reinforcements to the point where the remnant of the original patrol had taken up positions. Capt. Dick took over command of the medical personnel and, at approximately 0700L, departed from the OP with 16 aid men. Three aid men, under T/4 Charles T. Tsakonas, were ordered to remain at the OP, set up an aid station and handle the forwarding of supplies. Capt. Dick, prior to leaving the OP, contacted the Regimental Surgeon and requested that additional supplies and personnel be dispatched to set up and man a more complete aid station. The Regimental Surgeon left the Regimental CP for the OP with eight aid men at approximately 0730L, 15 February 1944, arriving there at approximately 0930L.

Capt. Dick, having departed from OP #7 with the forward element of the reinforcements, proceeded toward the point of the engagement. Enroute, four men were encountered bringing in a wounded man on a makeshift litter. Capt. Dick dropped out from the column to treat the wounded man. He administered two units of plasma, dressed the wounds and gave him a blanket. The aid men made the litter as comfortable as possible and the litter-bearers proceeded with the wounded men to the CP. Capt. Dick instructed the litter-bearers to request that additional supplies, particularly plasma, blankets and litters, be sent to him as soon as possible. Shortly afterwards, another group of litter-bearers carrying a wounded man

was met on the trail by Capt. Dick. This wounded man was also given two units of plasma, had his wounds dressed, was given a blanket and made comfortable before being sent on to the OP. This accounted for five of the six men wounded in the engagement of the previous day.

Having completed the treatment of the wounded on the trail, Capt. Dick and his medical personnel proceeded to rejoin the forward element of the reinforcements. They joined the reinforcements just after contact had been made with the original patrol. There Capt. Dick was informed that the sixth wounded man was on a cliff near the point of the attack of the previous day. About this time, two members of the Regimental Medical Section, T/5 Henry Searcy and T/5 Richard F. Jaeger, arrived at the scene with four litters, five units of plasma, morphine surette and other supplies. They attempted to contact Capt. Dick but before being able to do so learned of the whereabouts of the wounded man on the cliff. The two took a litter and a morphine surette and, despite enemy fire in the vicinity, crawled to the side of the wounded man. They administered morphine to the wounded man, examined his wounds, carefully placed him on the litter and moved him to a spot which officered more concealment. Here the two men attempted to administer a unit of plasma, but at this point they were fired upon and were forced to move the wounded man farther to the rear. The men could not return to the main body via the trail which they had come, due to the fact that the trail was too narrow for the litter. Thereupon, the two men decided to return by way of a stream at the foot of the cliff. They had gone about half-way across the stream when again were fired upon. The shots caused no damage and the men, carrying the litter through the rain-swollen, swift water, finally reached cover on the other bank. They then turned over the wounded man to Capt. Dick, who gave the patient four units of plasma, dressed his wounds, placed him in a blanket and made him as comfortable as possible.

It should be noted that this soldier had been wounded by enemy machine gun fire the day before. He could not be located during the withdrawal and, being unable to move, laid in the position where he had fallen overnight. The following morning, at approximately 0900L, he was discovered by a party of Japs. They gave him a butt stroke on the left side of the head, splitting his scalp open, and then bayoneted him twice, once in each side of the chest above the nipple line. One of these wounds extended completely through the chest and out of the back. In spite of these multiple wounds, the soldier was alive when recovered. Upon treatment by Capt Dick, he was taken back to the CP by members of an anti-tank company patrol, accompanied by T/5's Searcy and Jaeger and Pfc. Clyde Hackett, of the Regimental Medical Section.

At the CP aid station, the three wounded men were checked, given further treatment and then were taken in a vehicle by Pfc. Vertis R. Conn, of the 1st Battalion Medical Section, to the Division Clearing Station to further ascertain the condition of the six wounded. He left the aid station at CP #7 under the command of Capt. Arnet, who had arrived there early that day.

The bodies of the men killed the first day were recovered and buried near the point of the original attack. The coordinates of the graves was recorded on the Emergency Medical Tags.

Capt. Dick, along with the medical personnel assigned to him, remained with the main body of our troops which had made preparations to continue the original mission on the morrow, 16 February 1944. An overnight bivouac was set up and the men retired for the night. An artillery barrage commenced during the night and at approximately 0300I a shell fell short and wounded several men in the area occupied by men of Company "B", 129th Infantry. Because of the darkness and lack of communication, it was impossible to report this incident to the area where Capt. Dick and his medical personnel were stationed. However, an aid man attached to Company "B", Pfc.Frank W. Gudaitis, courageously crawled through the darkness from foxhole to foxhole in the sector where the shell hit, administering morphine to the wounded and dressing their wounds as best he could.

At approximately 0620I, four artillery shells fell short and exploded in the area where the command personnel of our forces had bivouaced. One shell hit within 25 feet of Capt. Dick and his medical personnel. The shell killed three men outright and wounded approximately 20 others, the majority of them seriously. Capt. Dick reached the three slain men just after the shells hit and found a fourth man very seriously wounded. He administered several units of plasma to the fatally injured soldier, but, despite all efforts, the patient died 45 minutes later.

With limited supplies and insufficient personnel to take care of so many wounded, Capt. Dick and his men for hours without a break treated the casualties. During that period, six wounded were given plasma, the wounds of all were dressed and the aid men carried the wounded to a point along the trail so that evacuation would thus be facilitated. A request had been dispatched by Capt. Dick to the CP for litters, supplies, litter-bearers and personnel to take care of the evacuation. These arrived under Capt. Ernst, who brought with him two aid men, T/4 Tsakonas and Pfc.Verdel L. Blair, and more than 100 enlisted men (to carry litters) from Company "A", 129th Infantry. They arrived after all but three of the wounded had been carried to the trail and plans for the evacuation were made immediately.

Just before the evacuation of the casualties got underway, Capt. Ernst examined the wounded and found one man whose wounds were of such severity that it was necessary to amputate his left leg immediately. The wounded man had been given five units of plasma prior to the amputation and two morphine surettes. Then, using a pocket knife--the only instrument available--Capt. Ernst amputated the leg. Later, on the trail enroute to the CP the man was given two more units of plasma.

Transports of the wounded to the aid station at the CP then began. There were 17 litter cases and these were

arranged in a convoy, the least seriously wounded in front and the most seriously wounded at the rear. There were approximately eight men to carry a litter, four men alternating per litter all along the slow, hazardous route. Security was provided by infantry personnel placed at the point, rear and flanks. Along the route, Capt. Ernst and T/4 Tsakonas continually administered aid and treatment to the wounded. Virtually everyone of the litter cases, as well as the walking wounded, were at one time or other during the trip treated. The convoy stopped at intervals where good cover was afforded and on these occasions the wounded were washed with cold water from the adjacent stream. The going was difficult throughout. At one point, on a steep precipice, it was necessary to line some 40 men on both sides and hand the litter down in chain fashion. Finally, after five long and arduous hours, the convoy of wounded reached the vicinity of the OP.

Approximately 250 yards ahead of the OP, the convoy came to the Laruma River. To reach the OP it was necessary to cross the stream. Swelled by the torrential rains which had fallen for two consecutive days, the current-whipped stream at some points was five feet deep. A rope had been stretched across the river and T/4 Tsakonas, with one walking wounded man, attempted to cross. About 10 feet out, the rushing water swept the wounded man clear of the rope and it was necessary for the men on the bank to pull him out. T/4 Tsakonas, with great difficulty, finally got to the other side, reached OP #7 and informed the Regimental Surgeon, in charge of the forward aid station, of the hazards entailed in crossing the river. A reconnaissance was made along the river at a point about 75 yards from the original crossing a large tree was felled in such a manner that it provided the convoy with a bridge. Two ropes were strung parallel three feet above the tree as rails of support. The convoy then began to move over the makeshift bridge. Straps were placed on the ends of the litters, and, with one man in front and another in the rear, the wounded were thus carried across. Construction of the bridge required approximately two hours, but the actual transport of the patients over it took less than half an hour.

Having reached the other side of the Laruma River, the convoy moved down the stream about 250 yards. From this point it was necessary to scale a steep hill to reach the aid station. A human chain, made up of at least 100 men, was formed on the hill and through this means the litters one by one were carried up. At the aid station, the men were checked and hot coffee, dough-nuts and cake were served to the patients and bearers by the medical personnel. Darkness had set in even before half the patients were assembled at the aid station and this further impeded the evacuation.

From the aid station at the OP, arrangements were made to evacuate the wounded as soon as possible to the Division Clearing Station. Previous to arrival of the convoy at the OP, 10 peeps with racks and two ambulances had been ordered to transport the wounded. Because of the rain-soaked

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condition of the trail leading to the Division road, the 6th Field Artillery Battalion was requested to send a tractor to the OP to assist in the transport of the wounded. The request was immediately granted and a tractor was at the OP long before the convoy arrived. The actual movement to the Division Clearing Station was brought about by hooking a peep to each of the ambulances--both of which were able to negotiate the muddy going--and chaining four other peeps to the tractor which pulled them to the Division Road. Thus all the patients were removed to the hospital, the last arriving by 2100L.

In summary, cognizance should be taken of the obstacles faced by the medical officers and personnel in treating and evacuating the casualties. The tireless, efficient, and courageous efforts of the medical officers on the scene, Capt. Dick and Capt. Ernst, was typical of the high traditions of the Army Medical Corps. Outstanding, too, was the work of the enlisted men of the Medical Detachment, under the capable leadership of Technical Sergeant Julius C. Wieczorek. Heavy enemy fire had to be braved several times to remove patients to safety. Wounded were administered morphine and blood plasma, brought up despite adverse and hazardous conditions to the scene of action. The convoy of litters had to accomplish the return to the aid station over a narrow, vine-crossed and muddy trail, made treacherously slippery by incessant rain, and over a distance of three miles--a feat in itself in jungle warfare. The crossing of the stream was made possible only by well-planned, hard work and, considering the obstacles, was completed in exceptionally fast time.

The problem of supply was exceptionally great. It was necessary to request and obtain numerous items over and above T/BA--such as heavy rope, musette bags, heavy wire, machetes, axes and shovels--in order to successfully complete the evacuation. Units of blood plasma, morphine surettes, first-aid dressings, blankets and litters and sulfadiazine had to be constantly brought up from the rear. The actual transportation of the patients by vehicles was made, in almost all cases, at night and care had to be exercised at all times to prevent unnecessary trauma to the patients.

Manpower, while available in large numbers, had to be utilized advantageously because of the hazards. Alternation of litter-bearers and the providing of security, in addition to the medical personnel, required at least 400 men for the entire evacuation. Tireless efforts by all concerned was necessary throughout.

Of great importance was the excellent cooperation by all units concerned in the evacuation. Personnel of Company "B", 112th Medical Battalion, ably assisted in all phases of the evacuation from the point of the river crossing. Approximately twenty enlisted men of Company "B", under the leadership of 2nd Lt. David T. Andrews, took part. Two ambulances and three jeeps with racks and an additional

supply of litters and blankets were dispatched by the Commanding Officer, Company "B", immediately upon request. Important, too, was the assistance of the 6th Field Artillery Battalion. Without the tractor furnished by that unit, it would have been virtually impossible to get the jeeps with the patients over the trail from the CP to the Division Road.

Finally, it cannot be too greatly emphasized how invaluable was the assistance rendered throughout the evacuation by the line officers and enlisted men of the 129th Infantry. Men assigned the arduous, slow task of carrying the litters of wounded did their job without complaint or slack. Officers who organized and led the convoy back through the jungles under conditions fraught with hazards performed their duty efficiently and courageously. At the river-crossing near OP #7, the incessant labors of all officers and men--notably Major Chan F. Coulter, Executive Officer, 129th Infantry; Captain John A. Brailsford, Commanding Officer, Company A; 1st Lt. William O. Beaty, Commanding Officer, Company B; and 1st Lt. Wilbur L. Wilkin, Company A--was the major factor in paving the way for the speedy and thorough execution of this treacherous phase of the evacuation mission.

WILLIAM T. HOLLADAY
Major, M.C.,
Surgeon, 129th Infantry.

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APPENDIX II
FREQUENCY DISTRIBUTION OF SHELL FRAGMENTS FROM JAPANESE MORTAR SHELLS

The following tests were made in order to determine the approximate frequency distribution of fragments from exploded Japanese mortar shells.

a. Disposition:

All tests were made on level ground (sand beach). The shells were detonated statically in vertical position with nose of shell pointing downward, the nose being slightly buried in the ground (ca.1 inch). Panels of cellotex were equally distributed in circles of 5, 10, 20, 25 and 30 yards radius, around the shell as centre. The panels were 4 feet high, 8 feet long and ½ inch thick. The distribution was such that in each circle the same fraction (1/6) of the same circumference was covered with panels. The outermost circle (radius 30 yards) had 12 panels, the next (radius 25 yds) 10 panels and so on. The innermost circle (radius 5 yds) had 4 half-size panels (4' x 4'). No one panel was covered by other panels with respect to the shell.

b. Detonation:

The shells were statically detonated by means of No. 8 commercial blasting cap and miners' safety time fuse. All detonations occurred without fail and were high order.

c. Shells:

The types and numbers of shells examined were as follows:

Type 89 50 mm. heavy grenade (knee mortar shell)	5 rounds
81 mm. mortar shell (Type 100, light, similar to U.S. M 43)	5 rounds
90 mm. mortar shell	4 rounds

All shells were of mild steel charged with high explosive (yellow bend). The type 89 grenade was detonated including propellant case and propellant, the 81 mm and 90 mm shells without propellant but with fin assemblies.

d. Recording:

The effect of each single round on each target was recorded separately. The relative position of the tests were drawn in rectangles representing the targets. Fragment holes larger than 1 cm in any one direction were marked especially with indication of size.

e. Fragments:

Very few fragments could be recovered. Their size was generally small 1/8 to 1/16 of an inch. Two larger fragments were approximately 1" x ½" x 1/16" in size, showing irregular leaf-shape with very sharp edges.

f. Results:

The blast had no marked effect on the panels and the same panels were used for all tests. Almost all fragments hitting a panel made a complete penetration through the board. Generally the cross section of the holes produced by fragments were larger in the rear than in front. Holes with front cross section of 1 to 2 cm^2 were observed in all six circles whereas pinholes as well as larger holes (over 2 cm^2 cross section) were relatively more frequent in the inner circles than in the outer. The distribution with respect to distance from bursting shell (radius) is different for the different types of shells. For the type 89 heavy grenade the relative frequency of shell fragments hitting a specific target appears to be inversely proportional to the square of the distance. For the 81 mm. and 90 mm. mortar shells it seems to be nearly inversely proportional to the cube of the distance. These results are shown in the following table:

TABLE I

1	2	3	4	5	6	7	8	9	10
Distance of panels from burst (radius of circle in yds.)	Counted hits on panels (panels cover 1/6 of each circle)			Number of hits calculated for full coverage of circles.			Values of col 5 x (r/5) 89 Grd.	Values of col 6 x $(r/5)^2$ 81mm M.	Values of col 7 x $(r/5)^2$ 90mm M.
	89 Grd. 5 rds.	81mm M. 5 rds.	90mm M. 4 rds.	89 Grd. 1 rd.	81mm M. 1 rd.	90mm M. 1 rd.			
r = 5	132	327	276	158	392	414	158	392	414
10	48	19	104	58	95	156	116	380	624
15	37	42	65	44	50	98	132	450	882
20	26	22	20	31	26	30	124	416	480
25	21	17	21	25	20	32	125	500	800
30	18	8	14	22	10	21	132	360	756

TABLE 2.

HIT PROBABILITY FOR HUMAN TARGETS.

DISTANCE IN YARDS	PROBABLE NUMBER OF HITS FOR TYPE OF SHELL.		
	89 Gr'd.	81 mm M.	90 mm M.
5	1.56	4.4	5.7
10	0.39	0.55	0.7
15	0.17	0.16	0.21
20	0.10	0.07	0.09
25	0.06	0.04	0.05
30	0.04	0.02	0.03
DISTANCE FOR ONE PROBABLE HIT.			
6.25	1		
8.2		1	
8.93			1

It is to be noted that the hit probability has been calculated on the basis of the mean projected area of a soldier. This is correct, because the directions of fragments from bursting shells are random. The values thus obtained do not show however, the probability for wounding or disabling a human target. They merely show the probability that a man will be hit by a fragment. The wounding probability could not be computed although the effective vulnerable area of a soldier to small fragments is known. The missing factors are the frequency distribution with respect to mass and velocity of the fragments and the wounding potentiality of a fragment of given mass and velocity. According to reports from the National Research Council, the frequency distribution can be calculated for the types of shells in question, because it is known for other types. The wounding potentialities of fragments, however, is almost unknown. It is this which forms the main subject in the program for investigation on wound ballistics.

This distribution is different from the distribution for the type 89 grenade and must be due to the difference in shape of the mortar shells as compared with the grenade. The grenade has approximately the shape of a little cylinder 2⅜ inches high and 2 inches in diameter. The mortar shells are approximately truncated cones with 81 mm (90 mm) base diameter, 21 mm (21 mm) diameter on top and 15 cm (23 cm) altitude. Therefore it is to be expected that a great part of the fragments are projected upward rather than horizontally. This behavior, however, will be partially offset when the shell detonates on impact in actual firing. The fragments will then have an additional velocity due to the motion of the shell along its trajectory. This velocity is pointing downward, whence the different trajectories of the fragments will be lowered proportionally.

g. Probability:

By using the data in Table 1 it is of interest to figure out the probability that a man, at a distance of 0 to 30 yards from a bursting shell, will be hit by a fragment.

This probability is a function of the distance and equals the number of hits which are expected at a given distance within the mean projected area of a soldier. The data in following Table are calculated by using the values in Table 1 (with certain adjustments) and setting the mean projected area of a soldier equal to 4.2 square feet. For each type of shell, the first six lines indicate the probable number of hits which a soldier would receive at the indicated distance. The last three lines give the distance at which the probability is one, that is the distance at which each bursting shell (of the same type) would score an average of one hit on a human target. This distance may be called the distance for one probable hit. A soldier who is at a closer range than this distance will more likely be hit by several fragments, whereas at a greater distance the probability of getting hit at all is smaller than one and decreasing rapidly with increasing distance. For the type 89 grenade the decrease is proportional to the square of the distance. For the two mortar shells the decrease is proportional to the cube of the distance. The probability decreases therefore more rapidly for the 81 mm and 90 mm mortar shells than for the type 89 grenade. Each line represents the group of panels belonging to the circle whose radius is given in Column 1. The numerals in Colums 2, 3 and 4, equal the total number of hits counted on each of the groups of panels. These hits were produced by the number of rounds for each type of shell as indicated in the heading. The same is true for Columns 5, 6 and 7 except that the totals are calculated as if circles were completely covered with panels and on the basis of one round. It is to be noted that these numerals do not represent the relative ratio of probable hits per unit of area for the different circles, but the number of hits expected on each full circle of panels. The total areas of all panels of any one circle is of course different for different circles and proportional to their respective radii.

Column 8 shows on each line the product of the values given in Column 5 with the corresponding r (in Column 1) divided by the common denominator 5. The numerals in Column 8 represent therefore relative values which can be obtained by multiplying the probable number of hits per unit of area for each particular circles with the square of the respective radii.

The values obtained do not show a marked tendency for increase or decrease for increasing values of r. They are all fairly close to an average constant. If this behavior can be confirmed by further tests it means that the frequency distribution for shell fragments from the type 89 heavy grenade is inversely proportional to the square of the distance from the bursting shell. The type 89 grenade would spray its fragments equally distributed in space, at least within the zone examined.

Columns 9 and 10 are obtained from Columns 6 and 7, as Column 8 is obtained from Column 5, with exception that the square of r/5 is used. If r/5 were to be used instead of the square, values would be obtained in Columns 9 and 10, which would show a marked decrease for increasing

values of r. The values, however, obtained by using $(r/5)^2$ do not show a typical tendency either for decrease or for increase. They are all of the same order of magnitude, although not very close to an average constant. It seems therefore and for the reasons given above that the frequency distribution for shell fragments from the 81 mm or 90 mm mortar shell is inversely proportional to the cube of the distance from the bursting shell.

ATTACHMENT XIX

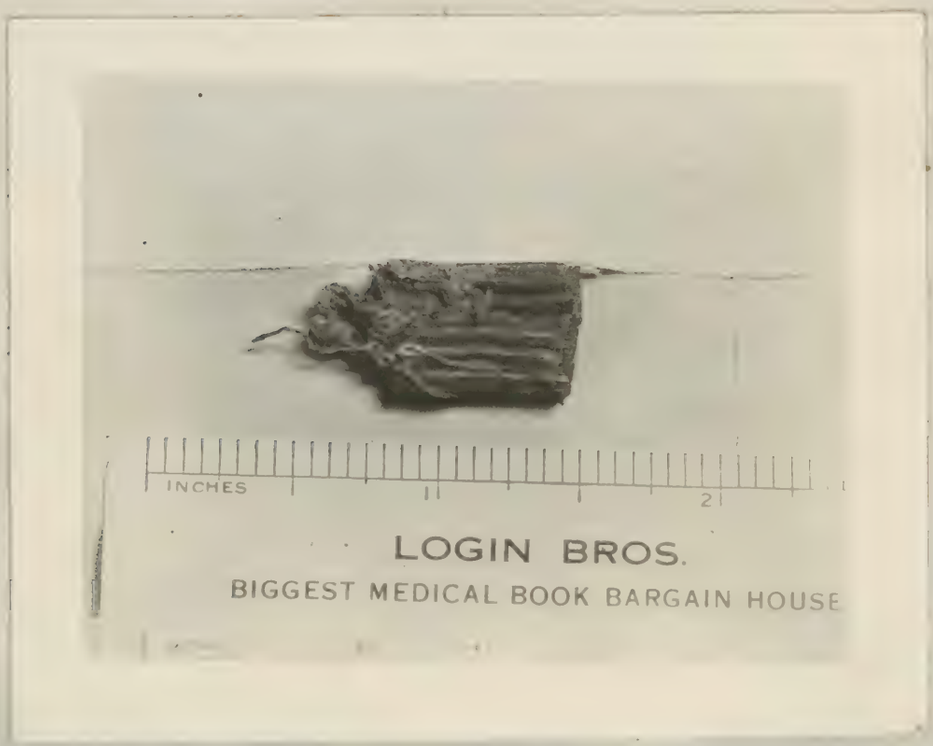
The following photographs illustrate some of the effects produced by different missiles from Japanese weapons.



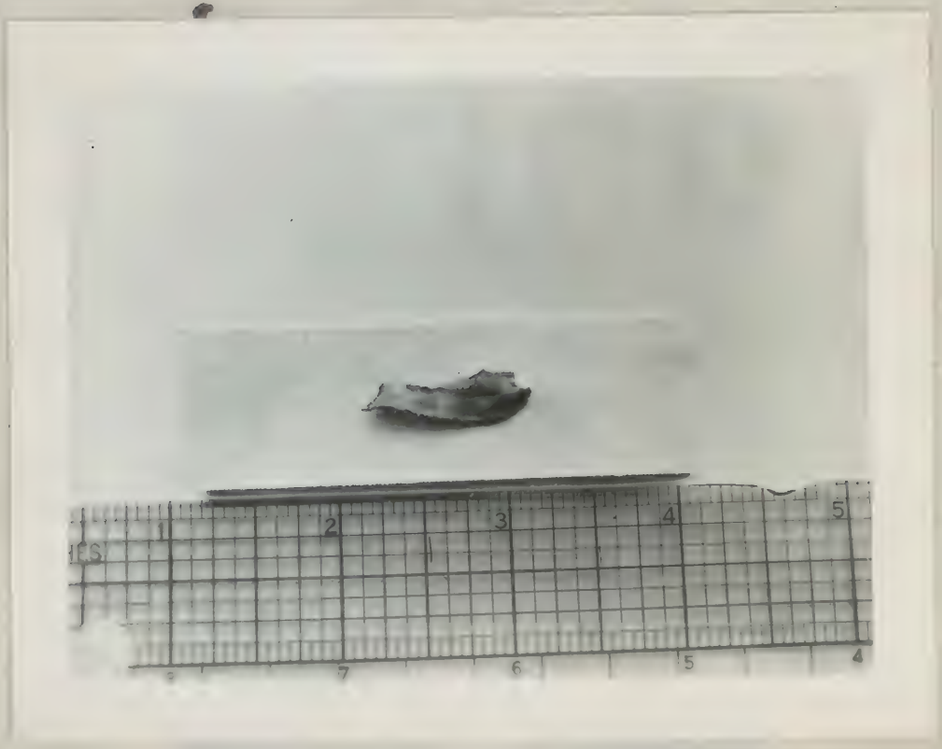
Compound comminuted fracture of the humerus caused by a Japanese .25 caliber rifle bullet fired from a distance of seventy five yards. This is a typical example of the explosive effect of the .25 caliber rifle bullet when it strikes bone or a solid organ. Many of these bullets cause similar damage to the eye and thus passed through the chest.



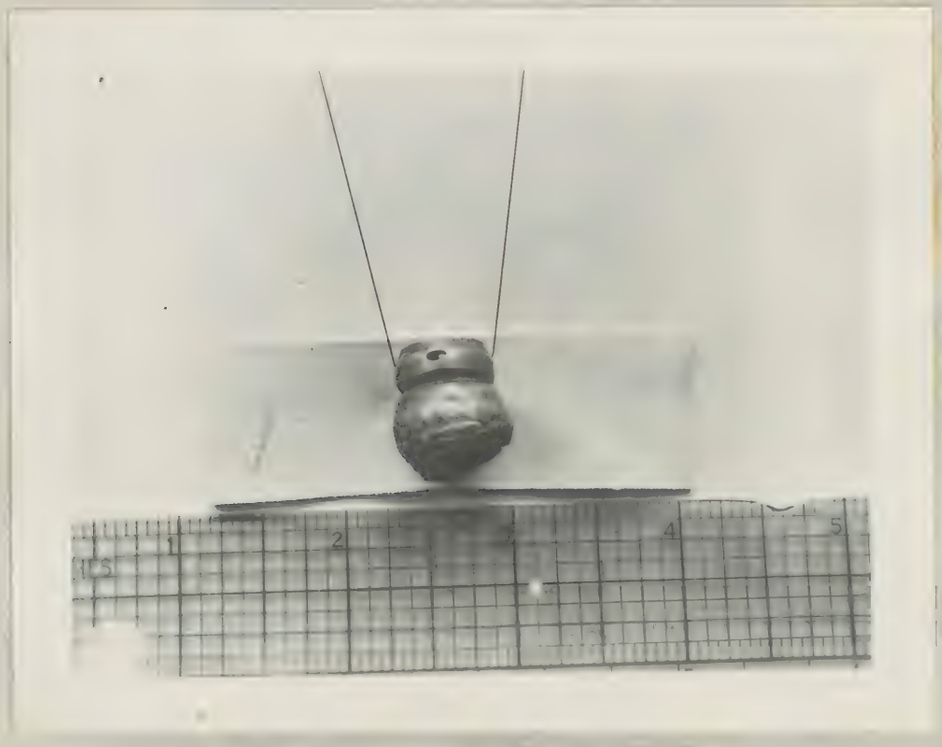
Fragments of wooden knife handle and .25 caliber bullet removed from the chest wall. The soldier was prone and the bullet fired from seventy five yards distant struck his knife resulting in a severe gutter wound of the pectoral muscle and nicking the pleura. He was evacuated to the U.S.



Fragment of a 50 mm. Japanese mortar shell with attached piece of clothing removed from infected pleural cavity. The shell burst in a tree twenty feet over head.



Strip of a detonator cap of a Japanese 50 mm. mortar shell removed from the chest wall. He was also wounded in the hand. The patient was prone and forty five feet from the burst but the fragment did not penetrate the pleura.



Fuse cap of a Japanese hand grenade removed from the neck of a soldier who was standing in a pillbox when the grenade exploded three feet from his head. He sustained multiple small penetrating wounds of the face, shoulders and lower lip with a fracture of the mandible by the fragment shown.



This X-Ray shows the characteristic small fragments of the Japanese hand grenade. This soldier was prone in a foxhole when the grenade exploded at a distance of not more than one foot from the chest wall. Most of the fragments were stopped by the chest wall but some of them penetrated the pleura. The fragmentation of this grenade is irregular but usually very small.



This patient was prone on the ground when a mortar shell of unknown size exploded one yard distant. He was also wounded in the arm, thigh and both ankles. He had an open operation and the numerous lacerations in the lung caused by the small fragments were sutured and the intercostal vessels ligated. He made a good recovery.





U.S. Hand Grenade

Japanese Hand Grenade

The photograph on the left is that of a wound caused by a U.S. hand grenade thrown by a Japanese. The grenade exploded three yards from the leg. The typical large fragment is shown.

The photograph on the right shows an explosive type fracture of the ulna and the usual small fragments characteristic of the Japanese hand grenade. The soldier was lying in a foxhole and the grenade exploded almost in contact with the arm. Under these circumstances there may be considerable blast effect on the soft tissues.



This soldier was standing in the company area when a Japanese 75mm artillery shell exploded at a distance of 100 yards. The fragment penetrated through the outer wall of the antrum and lodged within the sinus cavity. It is a good example of the relative protection afforded by bony structures of low velocity fragments, even of large size.

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